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WASHINGTON AND PARIS WINTERS.

By CLEVELAND ABBE, Jr.

[Dated Weather Bureau, Washington, D. C., Nov. 10, 1914.]

The preceding interesting paper on classifying Paris winters has encouraged us to prepare and present here a similar table for the same period for Washington, D. C. Willis E. Hurd and Herbert Lyman have assisted in the computations.

The central office of the United States Weather Bureau, latitude 38° 54' north, longitude 77° 3' west, elevation (present) 73 feet, was established at Washington, D. C., by the Signal Service on November 1, 1870. The city is situated on the Potomac at the head of tide-water. On its establishment in 1870, the Weather Bureau station was located at 1719 G Street NW., where it remained until August, 1888. On August 15, 1888, the office was moved diagonally across the street to 1744 G Street NW. The station remained in this location only a few months when, on March 29, 1889, it was moved about 4,100 feet northwestward to its present location in the Ferguson Building, at the southwest corner of Twenty-fourth and M Streets NW.

The thermometers have always been exposed in a standard louvered shelter on the roof of the office building. At the Ferguson Building they are at an elevation of 59 feet above the ground and 9 feet above the roof. The exposures on G Street placed them 9.8 feet above the roof and 57.5 feet above the street.

In our Table 1, as in the corresponding table for Paris, leaders (.....) indicate that there were no days in the month when the minimum fell to 32°F. (0°C.); 0 indicates that the minimum fell to 32°F., but not lower, while the exponent figure of the 0 indicates the number of times this minimum temperature was recorded. In the last two columns of our Table 1 are given the annual totals, expressed in both Fahrenheit and centigrade intervals; the incomplete total for 1871-72 has not been used in computing the average annual total; therefore the latter does not closely agree with the sum of the monthly averages. The readings of the Weather Bureau Fahrenheit minimum thermometers are recorded to the nearest whole degree; hence there are no known decimals suppressed in our monthly columns and no decimals appear in our °F column of annual totals for the same reason. The decimals in the centigrade totals result from the conversion into sums of centigrade intervals ($\frac{5}{9}$ of the Fahrenheit sums).

The average annual total of minimum temperatures below 0°C. (32°F.) at Washington, D. C., is 402.0°C. and 203.3°C. larger (colder) than that of Angot for Paris. At Washington the annual winter sum has varied between 165.5 C. for the warm winter of 1889-90 and 674.4 C. for the cold winter of 1903-4, limits that are not as wide as are those for the Parisian winters of the same period, but seem to be wide enough. The seven winters with the largest and the smallest sums are, respectively:

	°c.		°c.
1903-04.....	674.4	1889-90.....	165.5
1880-81.....	637.2	1881-82.....	225.0
1904-05.....	619.4	1877-78.....	230.5
1872-73.....	566.7	1879-80.....	241.6
1892-93.....	553.9	1908-09.....	246.1
1884-85.....	551.1	1912-13.....	248.3
1874-75.....	540.0	1890-91.....	255.5

The sums for the remaining winters fall between 300.0° and 525.0°C.

One of the most striking points brought out by Table 1 and the above list of our coldest winters is the fact that the seven coldest winters, as measured by this method,

fail to include the winter of 1898-99, which brought the lowest temperature (-15°F. in February) that Washington experienced during the period covered by the table.

TABLE 1.—Sums of intervals below 32°F., attained by the daily minimum temperatures at Washington, D. C., from 1872 to 1914.

Year.	October.	November.	December.	January.	February.	March.	April.	Year.	°F.	°C.
1871-72.....	(°)	(°)	(°)	261 ^a	193 ^b	207 ^a	2	666	370.0	
1872-73.....	99	300	276	211	134	134	1	1,020	566.7	
1873-74.....	7	68	69	164	169	66	30	503	312.7	
1874-75.....	0 ¹	45	108	319	373	101	26	972	540.0	
1875-76.....	0 ¹	51	147	133	175	95	3	604	335.5	
1876-77.....	2	13	389	332	89	103	0 ²	928	515.5	
1877-78.....	19	51	247	73	25	25	4	416	280.5	
1878-79.....	2	7	199	306	185	45	14	758	421.1	
1879-80.....	4	75	83	63	147	58	5	435	241.6	
1880-81.....	2	120	329	368	262	46	20	1,147	687.2	
1881-82.....	34	60	203	75	75	26	7	405	225.0	
1882-83.....	53	187	281	87	148	6	6	762	423.3	
1883-84.....	57	129	312	88	74	0 ¹	6	655	363.9	
1884-85.....	0 ¹	24	162	253	352	198	3	992	551.1	
1885-86.....	3	101	331	254	71	71	3	760	422.2	
1886-87.....	36	290	310	77	79	9	9	801	445.0	
1887-88.....	1	35	126	302	164	173	0 ¹	801	445.0	
1888-89.....	28	131	80	213	105	0 ¹	5	557	309.4	
1889-90.....	18	49	57	47	119	8	8	298	165.5	
1890-91.....	2	18	167	101	71	91	10	460	255.5	
1891-92.....	2	61	99	254	135	117	1	669	371.6	
1892-93.....	2	40	222	484	165	84	.....	997	553.9
1893-94.....	6	50	135	101	160	40	2	494	274.4	
1894-95.....	33	146	256	394	45	.....	.....	874	485.5
1895-96.....	8	35	144	192	165	155	10	709	393.9	
1896-97.....	1	15	209	304	103	25	3	660	346.6	
1897-98.....	26	106	123	202	25	15	15	497	276.1	
1898-99.....	2	39	190	255	395	44	14	939	521.6	
1899-1900.....	0 ¹	37	229	234	262	121	2	885	491.6	
1900-1901.....	22	162	185	290	69	.....	.....	728	404.4
1901-02.....	0 ¹	81	234	243	277	45	0 ¹	880	488.9	
1902-03.....	2	4	171	220	168	12	8	585	325.0	
1903-04.....	117	254	398	375	58	12	1,214	674.4	674.4	
1904-05.....	8	41	282	340	369	69	6	1,115	619.4	
1905-06.....	63	136	78	242	99	8	8	626	347.7	
1906-07.....	2	5	156	186	298	46	15	708	393.3	
1907-08.....	2	28	111	213	249	29	3	635	352.8	
1908-09.....	39	123	162	71	41	7	443	246.1	246.1	
1909-10.....	1	5	257	202	204	17	.....	686	381.1
1910-11.....	1	23	287	137	106	106	9	669	371.6	
1911-12.....	48	45	475	277	96	1	942	523.3	523.3	
1912-13.....	30	121	57	176	63	0 ¹	447	248.3	248.3	
1913-14.....	12	76	122	302	140	10	662	387.8	387.8	
Averages..	1.3	39.4	166.0	230.4	201.9	81.6	6.2	723.7	402.0	

NOTE.—a, b, c indicate 1, 2, and 3 days missing, respectively. (°) indicates no record. indicate no minimum as low as 32°F. 0¹, 0², indicate minimums fell to 32°F. on 1 and 2 days respectively but never fell below that temperature.

Table 2 shows at once by its column of differences that Paris has a warmer winter, usually a much warmer winter, than has Washington. On the average, the sum for a Parisian winter falls 203.3 units below the sum for a Washington winter, and this happens in spite of the fact that Paris lies 10° of latitude farther north. Since Paris lies about as far from the English Channel, (but farther from the Atlantic coast) as Washington does from our Atlantic coast, it is clear the warmer Parisian winter must be due to some other cause than mere proximity to the sea. The local topography is rather in favor of a warmer Washington, situated on a southward-facing slope, than a warmer Paris which is built on the floor of the basin of the Seine. The answer to the query raised by the contrasted winters is contained in the charts of the world showing the prevailing winter winds of the Northern Hemisphere (see Bartholomew's Atlas "Meteorology," Plate 14). The winter winds of France, notably western and northern France, are southwest winds that have swept over hundreds of miles of the waters of the subtropical North Atlantic before they reach the western shores of France. These surface winds have assumed almost the temperature that prevails in

the open oceans, of course a much higher temperature than the winter temperature of the lands and in this case not directly affected by drift from the Gulf of Mexico. Consequently the ocean-born air that drifts in over France during the winter has a temperature characteristic of the oceans of lower latitudes rather than of the continental land areas in the latitude of Paris. At Washington, on the other hand, the same charts show that its winter winds are drawn from the interior, not to say the great north-western interior of the continent of North America under its winter conditions. Such winds have assumed almost the temperature of the surface of the great continental interior and are drawn from even higher latitudes than that of Paris itself. There is thus a double reason why they are so continuously colder and drier than the air simultaneously passing over Paris. In brief, one may say that these tables comparing the severity of Washington and Paris winters furnish yet another demonstration of the already well-known fact that the western margins of terrestrial continents enjoy milder winters than do the eastern margins. In this particular case, however, one may go further and show, as pointed out above, that western Europe owes its mild winters to its position on the eastern boundary of a great perennially open ocean; it is evident that even those places, such as Paris, far removed from the direct influence of the Gulf Stream have far milder winters than their latitudes otherwise enjoy.

TABLE 2.—Washington and Paris winters compared by Angot's method. (Centigrade.)

Year.	Differences Paris—Washington.	Departures at—	
		Paris.	Washington.
1872-73.....	-514.7	-147	164.7
1873-74.....	-181.7	-48	-89.3
1874-75.....	-313.0	28	138.0
1875-76.....	-51.5	85	-86.5
1876-77.....	-440.5	-124	113.5
1877-78.....	-112.5	-81	-171.5
1878-79.....	-229.1	-7	19.1
1879-80.....	346.4	389	-160.4
1880-81.....	-422.2	16	235.2
1881-82.....	-82.0	-56	-197.0
1882-83.....	-301.3	-77	21.3
1883-84.....	-304.9	-140	-38.1
1884-85.....	-346.1	6	149.1
1885-86.....	-218.2	5	20.2
1886-87.....	-202.0	44	43.0
1887-88.....	-122.0	124	43.0
1888-89.....	-191.4	19	-92.6
1889-90.....	34.5	1	-236.5
1890-91.....	191.5	248	-146.5
1891-92.....	-103.6	69	-30.4
1892-93.....	-283.9	71	151.9
1893-94.....	-103.4	28	-127.6
1894-95.....	-73.5	213	83.5
1895-96.....	-284.9	-90	-8.1
1896-97.....	-260.6	-93	-35.4
1897-98.....	-121.1	-44	-125.9
1898-99.....	-384.6	-42	119.6
1899-1900.....	-296.6	-4	89.6
1900-1901.....	-216.4	-11	2.4
1901-02.....	-323.9	-34	86.9
1902-03.....	-127.0	-1	-77.0
1903-04.....	-511.4	-36	272.4
1904-05.....	-461.4	-41	217.4
1905-06.....	-213.7	-65	-54.3
1906-07.....	-163.3	31	-9.7
1907-08.....	-149.8	4	-49.2
1908-09.....	23.9	71	-155.4
1909-10.....	-251.1	-69	-20.9
1910-11.....	-230.6	-58	-30.4
1911-12.....	-462.3	-136	121.3
1912-13.....			-153.7
1913-14.....			-34.2
Average..	-203.3		

During the past 42 years, however, two winters (1879-80 and 1890-91) have been pronounced exceptions to the rule that Paris has milder winters than Washington, and two other winters (1889-90 and 1908-9) have presented slighter exceptions. The column of differences in Table 2 shows that the winter of 1879-80 was colder at Paris by the amount of 346.4 units. This change in sign, as well as the numerical difference, was due in part to the unusually warm winter then prevailing at Washington where its winter sum was 160.4 units above the Washington average, but in part it represents an actual long, cold winter at Paris. The column of Paris departures in Table 2, when taken with the monthly sums as given in the table on page 625, shows that December, 1879, at Paris, gave a sum of units 8 times larger than that for the average Paris December, and that it was the severest December Paris had experienced up to May, 1912. Washington was enjoying a December and January that were much warmer than the 42-year average. The second pronounced exception, the winter of 1890-91, was also an unusually warm one at Washington, where its departure amounted to 146.5 units below the average Washington winter sum as a result of a mild January followed by warm February and March (see p. 626). The same winter in Paris was actually the second coldest the city has experienced during the period under consideration, its departure of 248 units above the average being due to extreme and continued cold in December and January.

Of the two cases 1889-90 and 1908-9, the former is the more interesting since the balance in favor of Paris cold is here altogether due to exceptional conditions in North America; Paris enjoyed a strictly normal winter, as its departure of only 1 unit clearly shows. Washington experienced its most abnormally warm winter in this year. Its total "cold units," as shown by Table 1, page 626, amounted to but 165.5 C. units (298 F. units), thereby departing by 236.5 C. units from the average of 402 C. units. Table 1 shows that this warm winter was altogether in the months November to February, every one of which shows a sum far below the average monthly sums for those months, while March closed the winter with a sum much above the March average. The minimum temperatures for the winter months of 1889-90 were as follows:

TABLE 3.

1889-90	November.	December.	January.	February.	March.
	°F.	°F.	°F.	°F.	°F.
Extreme minimum.....	27	22	19	24	13
Mean minimum.....	39.3	36.3	35.8	35.7	32.7
Average minimum.....	37	29	26	27	33
Departure of minimum....	2	7	10	9	0

It appears from this little table of temperatures that the elements it presents do not fairly represent the winter 1889-90, as an unusual one at Washington, although it is apparent that the mean monthly minimum temperatures were somewhat above the average during the three months December to February. On the other hand Table 3 quite hides the fact that March, 1890, was much colder, all in all, than the usual March is. Its mean minimum of 32.7°F. was almost exactly the average March minimum, its extreme minimum of 13°F. was but little below the extreme minimum of January, 19°F.; whereas Table 1 shows that March, 1890, was much colder while January, 1890, was excessively warm.¹

¹ Those interested in the comparison of the two methods may find useful a compilation by Frank Gillam in the MONTHLY WEATHER REVIEW October 1898 26: 456.

Plus differences indicate that Paris was colder than Washington. Plus departures indicate local cold winters.

TABLE 4—Summary of Table 2 comparing Paris and Washington winters.

Paris, cold	} 1886, 1887, 1892, 1894.....	4
Washington, cold		
Paris, cold	} 1906.....	1
Washington, normal		
Paris, cold	} 1875, 1879, 1888, 1890, 1891, 1908.....	6
Washington, warm		
Paris, normal	} 1874, 1878, 1880, 1884, 1886, 1890.....	6
Washington, cold		
Paris, normal	} None.....	0
Washington, normal		
Paris, normal	} 1889, 1902, 1907.....	3
Washington, warm		
Paris, warm	} 1872, 1876, 1882, 1898, 1901, 1903, 1904, 1911.....	8
Washington, cold		
Paris, warm	} 1895, 1900.....	2
Washington, normal		
Paris, warm	} 1873, 1877, 1881, 1883, 1896, 1897, 1905, 1909, 1910.....	9
Washington, warm		

It is not the present purpose to further discuss the reasons underlying these constant differences between Paris and Washington or the occasional reversals in the relations. Undoubtedly their immediate causes are closely associated with the prevailing distribution of the great "centers of action," and the occasional disturbances arise from some dislocation of the latter. The chief aim has been to contribute the characteristic winter sums for Washington computed according to the method suggested by Dr. Angot; and to further examine the truth of his contention that these sums furnish a more useful and significant method for comparing winter conditions than do the usual means, extreme minima, and their departures.

It is hoped that in the future similar data for Washington may be presented for the period, 1838-1870, inclusive.

ON A METHOD FOR CLASSIFYING SUMMERS.¹

By ALFRED ANGOT.

[Translated for the MONTHLY WEATHER REVIEW by Miss R. E. Edwards.]

Several months ago the author proposed a method of classifying winters,² based on the comparison of the sums of the minimum temperatures below 0°C. These sums take into account both the intensity and the duration of the cold periods.

An analogous procedure may be applied to the summers by taking the sum of all the daily maximum temperatures above a certain limit. Take, for example, two different limits such as 25°C. and 30°C.; to form these sums one takes all the daily maxima, deducting from them the value which corresponds to the temperature chosen as the point of departure. In case 25°C. is selected as that point, a temperature of 25° or less will be counted as 0, a temperature of 26° as 1°, and so on. The two accompanying tables contain the sums of the maximum temperatures above 25° and 30°, respectively, at Parc Saint-Maur, Paris, for a period of 41 years. In Table 1 below it has seemed unnecessary to retain the fractions of a degree; the months in which the temperature has not once reached 25°C. are designated by leaders; the figure 0 indicates that there, on the other hand, the temperature has exceeded 25°C., but that the sum is less than 0.5°C. In Table 2 it has seemed necessary to give the fractions of a degree because of the smallness of the majority of the numbers that enter into the table.

Without going into a detailed study of these tables, we may indicate some of the general results they lead to.

Temperatures above 25°C.—The average annual total at Parc Saint-Maur is 117°C., distributed through the

seven months, April to October. The maximum monthly average sum is 43°C., and falls in the month of July. The annual sums are extremely variable, the three greatest and the three smallest are, respectively:

	°C.		°C.
1911.....	357	1910.....	22
1911.....	199	1882.....	31
1899.....	194	1879.....	37

During the 41 years here considered, then, the sums have varied between 22° and 357°; this gives a very extensive scale of comparison and permits a ready classification of the summers.

The maximum value, 357°, in 1911, is three times the average annual value and exceeds by nearly 160° the greatest maximum previously known, a fact that brings into prominence the altogether exceptional character of the summer of 1911. It is a curious fact that the two extremes of the series occurred in two consecutive years. One does not notice, at any rate not at first sight, that there is any periodicity in the hot summers and cold summers.

Not only are the annual sums very variable, but the distribution among the different months is also very irregular. The months that give the two largest sums in the average year are ordinarily July and August, but sometimes the largest sum characterizes June (as in 1877, 1878, 1885, 1888, 1889, 1897, and 1908), and in exceptional cases may even fall to September (as in 1891 and 1895). It would be interesting to investigate the relation of these sums to the phenomena of vegetation, and also the influence of early and late warm spells. These numbers seem to lend themselves better to this study than do the mean temperatures and the absolute extremes.

TABLE 1.—Sums of maximum temperatures exceeding 25°C. at Parc Saint-Maur, Paris.

Year.	April.	May.	June.	July.	August.	Sep-tember.	Octo-ber.	Year.
1873.....	0		14	56	43		1	114
1874.....	11	14	32	112	12	12		193
1875.....	3	9	25	9	41	10		97
1876.....		2	19	75	92	0		188
1877.....			65	30	36	1		132
1878.....		4	24	23	7	2		60
1879.....			2	6	27	2		37
1880.....		17	9	43	31	21		121
1881.....		1	11	120	12			144
1882.....	1		3	14	10	3		31
1883.....		18	16	22	38			94
1884.....		17	16	75	76	9		193
1885.....	0	6	47	39	19	6		117
1886.....	2	8	4	45	39	25	1	124
1887.....			33	66	34			133
1888.....		3	28	3	22	7		63
1889.....		2	44	30	22	13		111
1890.....		9	11	21	17	2		60
1891.....		1	8	10	9	14		42
1892.....		38	19	32	60	7		156
1893.....	14	4	39	45	69	6		177
1894.....	0	7	12	41	16	6		82
1895.....		8	15	20	32	100		185
1896.....		4	16	55	2	0		77
1897.....		4	30	17	17	1		69
1898.....		1	3	16	86	42		148
1899.....		1	25	54	94	20		194
1900.....	1	4	26	129	22	15	2	199
1901.....		7	38	70	38	6		159
1902.....		2	15	43	11	5		76
1903.....		14	16	22	8	15		75
1904.....		10	15	117	46			188
1905.....		8	14	49	23	2		96
1906.....		7	27	48	47	33	0	162
1907.....		10	3	9	35	7		64
1908.....		6	32	26	11	7	1	83
1909.....	2	15	4	0	38			59
1910.....		0	8	8	5	1		22
1911.....		3	14	119	133	88		357
1912.....		16	16	44				76
1913.....	2	16	8	4	19	1		49
Averages.....	0.9	7.2	19.6	48.1	34.1	12.1	0.2	117.2

¹ Angot, Alfred. Sur un mode de classification des étés. Annuaire de la Société météorol. de France, Paris, Décembre 1913, 61: 341-345.
² See page 625, above.