This was the first taste of real winter. Lamp was lighted in the house for the first time this evening.[2] This was needed on account of the cloudiness and the fact that the sun disappears behind the mountains in the west and north on Amsterdam Island. Snowfall at 6 p. m. measured .15 inch.

August 28.—Light snow during the preceding night followed by cloudy with brisk northeast wind. Light snow flurries at intervals from 10 a. m. to 2 p. m. Temperature below freezing all day.

August 29.—Cloudy, cold weather with brisk northeast wind in the forenoon, becoming light in the afternoon. Traces of rain and snow at intervals until 2 p. m., the rain freezing as it fell. Heavy snow flurry, 3:30 p. m. to 3:45 p. m., followed by occasional lighter ones. Wind became light and shifted to west about 2:30 p. m. Snow on ground at 6 p. m., 1 inch.

August 30.—Cloudy with occasional snow flurries. Light westerly wind.

August 31.—Snow continued all night with temperature below freezing. Snow 4 inches deep at 7 a. m. Snow flurries at intervals all day with fresh westerly wind. Snowfall for preceding twenty-four hours at 6 p. m., 6 inches; depth on ground, 5 inches.

The expedition departed from Danes Island on September 4, 1906, leaving the instruments in charge of Mr. Felix Riesenberg, who will continue the meteorological observations thruout the year. The meteorograph, however, was brought back to Paris and left with Richard for repairs.

A CLIMATIC SKETCH OF TACOMA, WASH.

By E. B. GITTINGS, jr., Assistant Observer. Dated Tacoma, Wash., February 27, 1907.

The object of this sketch is to present in popular form as complete a description of the climate of this station as is possible without the introduction of extensive tabular compilations of data. To the ordinary reader nothing can be less interesting than column after column of figures. It is true that these figures are very necessary to the complete understanding of a climate in all its varied phases. Still it is believed that by presenting and briefly describing the most important features to be found in the tables it is possible to convey to most people a much better general knowledge of the climate of a place than they would be able to gain for themselves, even if they were patient enough to delve into the figures.

The records on which this paper is based are those of the Weather Bureau from May 1, 1897 (on which date this station was established) to January 31, 1907, so that while the period covered lacks three months of a full ten years, yet it includes ten Januarys and ten Julys. The subject will be treated under the following heads: Rainfall, temperature, and miscellaneous conditions (including sunshine, cloudiness, etc.).

RAINFALL.[1]

As the rainfall is perhaps the most interesting phase of the climate of this section it will be treated first. Among the important things to know about rainfall are the total amount that falls annually and the distribution of the annual amount among the different seasons, the latter especially when the distribution is very unequal, so that there are a wet season and a dry season, as is the case at this station. Next, considering each season separately, we wish to know, in addition to the seasonal distribution of the total annual rainfall, the following particulars: The period of time over which each season extends, and the greatest number of consecutive rainy days and of days without rain that usually occur in each. Subdividing the seasons into months and considering these separately, it will be of interest to determine the intensity and the probability of rainfall for each month.

As a description of rainfall is incomplete without mention of its special features, attention will also be given to the frequency and intensity of excessive monthly and daily rainfalls, and (since it is not of sufficient importance at this station to be considered separately) some information concerning the snowfall will be given.

Annual and seasonal rainfall.

The average annual rainfall at Tacoma is 45.36 inches, the greatest amount recorded in any one year being 54.67 inches, the least amount 35.58 inches. Of the average annual amount 34.15 inches, or 75.3 per cent., falls from October 1 to April 1, so that the wet season may be said to cover the six months beginning with October and ending with March, the other six being the dry season. The average monthly amounts for the wet season range from 3.30 inches in October and 3.91 inches in March to 8.67 inches in November and 7.08 inches in December; for the dry season the range is from .64 inch in July and .59 inch in August to 2.91 inches in April and 2.52 inches in September. These figures show that the rainfall in November and December is copious and that July and August are almost rainless.

Wet and dry periods.

Defining a rainy day as one on which .01 inch or more of rain falls, we may expect annually 162 rainy days. As a rule, there will be 9 or 10 consecutive rainy days in each month from November to February, inclusive. The longest rainy period on record for the rainy season is 23 days; the longest period without rain in measurable amounts is 15 days. During the dry season there will, as a rule, be only 2 consecutive rainy days in July and August and 4 consecutive rainy days in each of the other four months. The longest rainy period recorded for the dry season is 9 days; the longest period without rain is 39 days.

Intensity and probability of rainfall.

If we divide the average amount of rainfall in inches during any month by the average number of rainy days in the month, we obtain what is known as the average intensity of rainfall in inches for a day in that month. In the wet season the intensity varies from .25 in October and .24 in March to .35 in December and .41 in November. In the dry season the range is from .16 in July and .15 in August to .22 in April and .25 in September, the decimal representing the fraction of an inch in each case.

By dividing the number of rainy days in any month by the number of days in the month we obtain the probability of rainfall for that month. In the wet season the probability exprest in percentage ranges from 42 per cent in October and 52 per cent in March to 65 per cent in December and 70 per cent in November; in the dry season the range is from 13 per cent in July and August to 33 per cent in September and 43 per cent in April.

Excessive rainfalls.

When 10 inches or more of rain falls in a month the rainfall for that month is considered excessive; for 24 hours a fall of 2.50 inches or more is excessive; and for a single hour a fall of 1 inch or more is excessive.

During the past ten years there have been seven months when the rainfall was excessive, five Novembers and two Decembers, the greatest monthly fall on record being 14.48 inches in December, 1897. There have also been five excessive daily rainfalls, the heaviest 24-hour fall being 3.79 inches in November, 1904. A fall of 1 inch in a single hour has never been recorded.

Snowfall.

The average annual snowfall at Tacoma is 15 inches. As a

[2] See footnote [1], under June 21.

[1] Thruout this article whenever the writer uses the expression "rainfall", he evidently includes the amount of melted snow, if any.

rule, most of the snow melts as it falls. No snow has ever been recorded from May to October, inclusive, and only three times in April and five times in November. The average number of days annually on which snow falls is eight, the greatest number in any one year being thirteen, the least, two. The month of maximum snowfall is January, with an average of 6.6 inches. The heaviest fall recorded in twenty-four hours was 8 inches, in January, 1899. The average maximum depth to which snow accumulates on the ground is 5.9 inches. The greatest depth it ever attained was 16 inches, in January, 1899. The greatest number of consecutive days with snowfall in appreciable amount was 4.

General remarks on rainfall.

A few general remarks concerning the rainfall may serve to make this description more complete. The statement that in the winter months periods of ten days' rains are to be expected does not mean that the rainfall during these days is incessant. The fact is that very much of the rainfall is intermittent; periods of several hours at a time when it does not rain are quite frequent even during the wettest periods of the rainy season. Sometimes there is sunshine for an hour or so between showers. The somewhat prevalent notion that the rainy season here is one of an unending downpour is quite erroneous. Another point worthy of notice is that exceedingly heavy showers, such as those that accompany thunderstorms and cloudbursts, are almost unknown here; the fact that an hourly fall of 1 inch has never been recorded bears out this statement.

TEMPERATURE.

In considering the temperature conditions we shall find that there are no well-defined periods separating the seasons from one another; in fact the transition from summer to winter and from winter to summer is so gradual that it is scarcely more noticeable than is the seasonal change from the long days of summer to the short ones of winter.

The mean annual temperature is 50.9°. The mean monthly temperatures have a range of 23.7° from 63.3° for July to 39.6° for January. The extreme monthly range (that is, the difference between the warmest month and the coldest month on record) is 34.4° from 68.0° for July, 1906, to 33.6° for January, 1907. The means of the extreme monthly temperatures are as follows for the months given: July, maximum 88.6°, minimum 47.9°; January, maximum 55.2°, minimum 21.7°. The means of the daily maxima and the daily minima are: for July, maxima 73.2°, minima 53.3°; for January, maxima 44.2°, minima 34.9°. The first group (means of extremes) indicates that at least once in July a maximum of about 88.6° and a minimum of about 47.9° will usually occur; in January a maximum of about 55 2° and a minimum of about 21.7° may be expected. The extreme maximum on record was 98.0° in July, the extreme minimum 9.0° in January, giving a total range of 89.0°. The second group (means of maxima and of minima) shows the means of the daily maxima and of the daily minima for the respective months and it is of more importance from a climatological standpoint, as it shows more nearly what are the usual conditions.

There usually occurs one day each year with a temperature of 90° or over, and with the exception of one period of three successive days, more than one day at a time with a maximum of 90° or over has not been recorded.

In comparing these maximum temperatures with those of continental, or dry and mountainous regions, it must be remembered that a high degree of temperature in this climate will be found very much more oppressive than will the same degree in those regions. This is explained by the fact that the relative humidity at this station is rather high even in summer, so that the so-called sensible temperature, or that actually felt by the human body, is also quite high. The high summer humidity is due to the prevailing northerly winds becoming charged with moisture from the surface of Puget Sound, which extends northward from this station.

The freedom of the winters from long-continued cold spells and from extremely low temperatures is much more noticeable than is the lack of hot weather in summer. In fact it is chiefly to the mildness of the winter season that the equability of temperature at this station is due. The average number of days annually on which the minimum temperature falls below the freezing point is 29, these days usually occurring between November 1 and April 1; and in October about three times in five years, in April about once in three years. The greatest number of successive days ever recorded with minima below freezing is 13.

Frosts.

The average date of the first killing frost in autumn is November 19, the earliest ever recorded occurring October 18. The average date of the last killing frost in spring is April 1, the latest ever recorded occurring April 8.

Daily range and variability.

The mean daily range of temperature varies quite uniformly from 19.9° in July to 9.4° in December and January.

The mean variability, or the change in temperature from one day to the next, ranges from 2.6° in August and September to 3.5° in December, showing that great changes from day to day are remarkably infrequent at all seasons of the year.

SUNSHINE, CLOUDINESS, AND MISCELLANEOUS CONDITIONS.

The average annual sunshine at Tacoma amounts to 40 per cent of the possible. The sunniest year on record was 1898, with 51 per cent; the year of least sunshine was 1903, with 28 per cent. The sunshine is very unequally distributed thruout the year, this distribution following closely the dry and the rainy seasons. The month of maximum sunshine is July, with an average of 63 per cent; that of minimum sunshine, December, with an average of 11 per cent. The sunniest month on record was July, 1906, with a percentage of 84; the month with the least sunshine was November, 1904, with a percentage of 2.

These figures show that in the dry season sunshine is quite plentiful, but in winter the sky is usually overcast. During the five successive months from October to February the average percentage of sunshine for the entire period falls to 23.

The average annual cloudiness is 67 per cent, ranging from 42 per cent in July to 86 per cent in December. For the year there are 72 clear, 101 partly cloudy, and 192 cloudy days; for July, 15 clear, 10 partly cloudy, and 6 cloudy days; for December, 2 clear, 4 partly cloudy, and 25 cloudy days.

There is an annual average of 39 foggy days, 5 of which occur during the dry season and 34 during the rainy season. There has been only one dense fog in July during the ten years covered by the records, while there are, as a rule, 8 foggy days in December.

A light smoke from forest fires usually sets in about the 1st of August, and generally it continues almost unabated, completely obscuring the horizon, until the middle of September or the 1st of October, when the first general rains serve to extinguish the fires. This smoke occasionally becomes so dense as to obscure the sun as effectually as would thick altostratus clouds.

From thunderstorms and violent winds Tacoma is remarkably free. As a rule, there are about three thunderstorms in a year, and most of those that occur are hardly noticeable, it usually being impossible to observe any of the lightning that accompanies them. The highest winds occur during the winter. Most of them are of less intensity than gales and do not do any great damage. The only damaging winds are those from the northerly quarters, which cause considerable trouble to the shipping in the harbor; these northerly blows are very

TABLE 1.—*Monthly rainfall, in inches, at Tacoma, Wash.*

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l.
1897...	.....	.....	.....	.....	1.46	1.54	0.87	0.58	1.41	1.63	12.31	14.48	.....
1898...	3.01	8.68	0.97	2.26	1.12	2.41	0.26	0.38	4.24	1.60	5.92	4.73	35.58
1899...	9.17	4.50	3.82	4.58	2.75	1.27	0.21	2.26	1.93	3.23	10.11	7.05	50.88
1900...	4.97	4.66	5.51	1.77	4.62	3.22	0.33	0.84	1.57	6.13	5.23	7.97	46.82
1901...	6.48	6.56	2.97	5.93	2.26	1.46	0.50	0.32	2.42	2.60	9.62	4.63	45.75
1902...	6.21	7.78	5.00	2.96	1.83	1.87	1.91	0.20	2.75	2.88	10.84	10.44	54.67
1903...	8.23	1.35	5.83	3.05	1.69	2.59	0.80	0.75	3.59	2.72	10.00	4.51	45.11
1904...	6.39	7.57	6.08	3.84	1.04	1.36	0.94	0.07	0.40	1.27	11.88	5.07	45.91
1905...	4.93	2.51	3.78	0.71	4.15	3.23	0.34	0.39	2.79	5.50	3.08	5.19	36.60
1906...	5.83	3.95	1.26	1.09	2.90	2.75	0.21	0.08	4.11	5.46	7.74	6.72	42.10
1907...	3.92	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Av'ge.	5.91	5.23	3.91	2.91	2.38	2.17	0.64	0.59	2.52	3.30	8.67	7.08	*45.36

Averages in black figures are from 9 years record. *Sum of monthly averages.

TABLE 2. – *Mean temperature, in degrees F., at Tacoma, Wash.*

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l.
1897...	.....	.....	.....	.....	57.2	59.0	61.4	66.2	56.0	50.0	42.9	41.7	.....
1898...	38.4	44.8	42.0	49.2	55.4	60.3	63.8	65.6	59.6	50.6	43.4	38.5	51.0
1899...	40.4	38.0	42.5	47.2	50.6	56.9	64.0	59.6	60.0	50.7	50.9	42.7	50.3
1900...	42.2	41.7	49.0	50.4	55.2	61.4	64.0	61.2	57.2	50.0	42.6	44.2	51.6
1901...	39.3	41.6	44.6	46.4	53.4	56.1	60.8	64.2	56.0	56.0	47.6	40.8	50.6
1902...	33.4	45.2	43.8	48.2	55.5	59.1	62.3	62.9	57.0	53.0	44.4	40.6	50.9
1903...	41.5	38.7	41.6	46.4	53.3	60.8	60.8	62.3	56.7	52.2	45.3	41.0	50.0
1904...	41.0	38.1	41.6	51.3	53.6	58.0	63.2	62.9	60.2	53.6	48.7	42.7	51.2
1905...	39.3	42.2	48.6	51.3	54.1	59.0	64.8	62.6	59.4	47.4	43.8	40.7	51.1
1906...	41.4	42.7	44.2	52.0	54.2	57.8	68.0	64.1	58.6	53.0	44.2	41.8	51.8
1907...	33.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Av'ge.	39.6	41.4	44.2	49.2	54.2	58.8	63.3	63.2	58.1	51.6	45.4	41.5	50.9

Averages in black figures are from 9 years record.

TABLE 3.—*Average cloudiness, percentage, at Tacoma, Wash.*

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l.
1897...	.....	.....	.....	.....	54	74	41	27	58	65	90	87	.....
1898...	80	80	56	58	45	50	31	43	50	60	80	74	59
1899...	90	81	67	71	76	57	36	69	43	74	87	90	70
1900...	79	80	71	65	70	63	36	58	60	75	75	88	69
1901...	78	60	71	64	63	70	43	37	52	69	83	86	65
1902...	78	83	77	72	73	56	55	37	53	79	94	98	71
1903...	95	68	73	74	75	74	56	67	71	62	91	83	74
1904...	85	88	66	60	52	46	51	50	49	72	86	82	66
1905...	70	56	69	52	70	66	44	54	73	69	72	89	65
1906...	94	76	71	65	74	66	30	42	59	68	83	81	67
1907...	67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Av'ge.	82	75	69	65	65	62	42	48	57	69	84	86	67

Averages in black figures are from 9 years record.

TABLE 4.—*Prevailing wind directions and average hourly velocities at Tacoma, Wash.*

Date.	Jan.		Feb.		Mar.		April.		May.		June.		July.	
1897....	.....		.....		.....		.....		*	*	sw.	6.0	sw.	6.4
1898....	sw.	5.8	sw.	7.6	sw.	7.2	n.	5.8	sw.	6.5	n.	5.6	n.	5.7
1899....	sw.	7.1	sw.	8.9	sw.	8.3	sw.	8.4	sw.	5.6	sw.	6.6	n.	5.4
1900....	sw.	5.4	sw.	6.7	sw.	5.5	n.	5.6	sw.	6.0	n.	5.9	n.	5.3
1901....	s.	6.2	s.	7.8	sw.	6.9	n.	6.6	sw.	5.4	sw.	6.7	n.	5.4
1902....	s.	5.2	sw.	6.0	sw.	7.7	sw.	6.2	sw.	6.2	n.	5.8	n.	6.1
1903....	sw.	6.7	s.	4.5	n.	7.4	sw.	6.6	sw.	6.3	n.	5.2	n.	5.4
1904....	sw.	7.1	sw.	8.1	sw.	8.3	sw.	5.8	n.	5.8	n.	6.3	n.	6.1
1905....	sw.	4.9	n.	5.9	n.	6.5	n.	6.1	sw.	6.7	sw.	5.2	n.	4.8
1906....	sw.	6.2	sw.	4.6	n.	6.9	n.	5.2	sw.	5.7	sw.	6.4	n.	5.1
1907....	sw.	7.4	.....		.....		.....		.....		.....		.....	
	sw.	6.2	sw.	6.7	sw.	7.2	n.	6.3	sw.	6.0	n-sw.	6.0	n.	5.6

Date.	Aug.		Sept.		Oct.		Nov.		Dec.		Annual.	
1897.....	n.	4.8	n.	4.2	n.	4.1	sw.	7.1	sw.	6.4	.....	.....
1898.....	n.	4.3	n.	5.3	sw.	5.4	sw.	7.2	sw.	5.2	sw.	6.0
1899.....	sw.	5.4	n.	4.0	sw.	5.5	s.	5.0	sw.	6.5	sw.	6.4
1900.....	sw.	5.2	n.	4.6	sw.	6.3	sw.	6.1	s.	6.2	sw.	5.7
1901.....	n.	4.4	n.	5.1	sw.	4.4	sw.	5.8	sw.	6.8	sw.	5.9
1902.....	n.	4.9	n.	5.4	sw.	3.5	sw.	7.2	sw.	6.7	sw.	5.9
1903.....	n.	4.5	n.	5.8	n.	5.1	sw.	6.2	sw.	4.2	n.	5.7
1904.....	n.	4.1	n.	4.0	n.	4.5	sw.	5.9	sw.	6.6	sw.	6.0
1905.....	n.	5.4	sw.	5.9	n.	5.8	sw.	4.5	sw.	5.7	sw.	5.6
1906.....	n.	4.4	n.	5.2	sw.	6.3	sw.	6.1	sw.	5.7	n.	5.6
1907.....	.....		.....		.....		.....		.....		.....	
	n.	4.7	n.	5.0	sw.	5.1	sw.	6.1	sw.	6.0	sw.	5.9

Averages in black figures are from 9 years record. *No record for May, 1897.

infrequent, however. By far the greater number of high winds come from the southerly directions. The number of gales (winds of 40 miles or over per hour that continue for periods of at least five minutes) is usually about two in three years. The highest wind velocity ever recorded at this station was 46 miles per hour from the southwest.

TABLES.

For the benefit of those who desire more detailed information than that given above, the preceding tables, showing the monthly rainfall, temperature, cloudiness, and the average hourly velocity and prevailing direction of the wind for the same period have been compiled.

SNOW ROLLERS AT CANTON, N. Y.

By M. L. FULLER, Observer. Dated Canton, N. Y., March 30, 1907.

I send a few notes relative to the formation of snow rollers in the village of Canton on February 19, 1907.

The conditions attending the formation of the rollers were as follows: Upon a dry and evenly distributed snow covering of 4 inches depth there fell late in the forenoon of the 19th a half inch or more of fine, dry snow. After 1 p. m. the falling snowflakes were of greater size, becoming large, moist, and feathery after 3:25 p. m. and continuing to 4:25, by which time a total of about one inch had fallen. Light snow, with about one-tenth inch of dry sleet, occurred from 4:25 to 6:55 p. m.

The temperature, from 10° F. at the 8 a. m. observation, increased to 17° by 3:15 p. m., then rose suddenly to 31° at 3:30, and slowly to 34° by shortly after 6 p. m., from which maximum it fell to 17° by 7:15 p. m.

This abrupt rise of temperature and brief thaw accompanied a southwest wind with a velocity of 30 to 40 miles per hour that burst suddenly upon this locality at 3:25 p. m., displacing the northeasterly winds of 4 to 12 miles of the morning and midday, which had continued practically up to that hour.

Tho the formation of the rollers was not witnessed, so far as ascertained, it is known to have occurred in the late afternoon or early evening, probably between 5 and 6 p. m. Small rollers were found next morning in a variety of locations. The largest had been developed on a sloping lawn where the strong wind, striking the exposed side of a large cottage, had swept downward and away, rolling the snow downhill. Here the largest attained diameters and lengths of 10 to 12 inches. In structure they closely resembled rolls of cotton batting, but the centers were almost invariably shorter than the outer layers. The layers were plainly marked and varied somewhat in thickness, averaging probably three-fourths of an inch or more and being usually thinner near the axis. In occasional instances the centers were very short or almost wanting; and the rolls, altho firm enough next morning to be handled, were much lighter than snowballs of the same size when rolled by hand, thus indicating but slight packing of the snow in the wind rollers.

From the conditions observed in this instance it would appear that the flakes of a light, fluffy layer of surface snow are made adhesive by a sudden rise in air temperature while the under snow still remains cold and dry, and the particles of damp surface snow are enabled to adhere to each other but not to the dry under snow. A strong wind may then push over little prominences or projections of the surface snow and start them rolling, when of course they will continue to travel and grow until the resistances overcome the propelling power of the wind.

The accompanying photographs [see figs. 1 and 2] of the Canton rollers were taken by Mr. Ford Moran, of the class in climatology at St. Lawrence University.

Another member of the class in climatology, Miss Ione A. Jillson, subsequently reported having once witnessed the formation of snow rollers, and at the suggestion of the writer