1901–1905, leaving out the months of this depression. These means are presented in the following Table 2.

TABLE 2.—*Mean annual summary, based on actinometric measurements made at Warsaw during 1901–1905, omitting December, 1902—February, 1904.*

1 Month.	2 Monthly mean. Q	3 h	4 Q 30°; mean distance.	5 n	6 f	7 Max. Q
		°				
I	0.829*	17	1.010	14	3.0	0.937
II	1.082	25	1.126	12	2.7*	1.242
III	1.140	36	1.063	18	3.8	1.324
IV	1.135	47	1.047	19	5.4	1.320
V	1.164	56	0.998	48	7.0	1.346
VI	1.118	61	0.944	32	9.1	1.294
VII	1.173	59	1.008	35	9.7	1.328
VIII	1.119	51	0.975	31	10.3	1.269
IX	1.159	41	1.063	32	8.0	1.367
X	1.036	29	1.042	15	6.8	1.241
XI	0.887	20	1.018	15	3.6	1.049
XII	0.862	15	1.088	7	4.2	0.975
Mean			1.017	278	7.1	

The monthly means, Q, of the "*mean annual summary*" (Table 2) are represented graphically in curve m, fig. 2; the curves for each of the consecutive years 1901–1905 are presented in the same figure by lines that are numbered for the consecutive years and that are based on the data of Table 1, column 2.

7. *On the march of the depression of solar radiation as observed at Warsaw.*—By comparing the monthly values of the period December, 1902, to February, 1904, (see Table 1) with the annual summary, Table 2, it is seen that—

(*a*) The depression is suddenly emphasized in the month of December, 1902, giving at Warsaw from its beginning, a value about 20 per cent lower than those of the mean annual summary.

(*b*) On account of this great depression the whole annual march of the intensity of solar radiation in 1903 undergoes a perturbation which has masked, or even changed, the usual variation of radiation, during that year at Warsaw.

(*c*) This depression, persisting from the month of December, 1902, until the month of February, 1904, inclusive, and giving a mean diminution of intensity exceeding 15 per cent at Warsaw, has not had a uniform character in its march, but on the contrary has presented several oscillations.

(*d*) After a sharp and large diminution in December, 1902, and after the particularly low values of the intensity in the months of February and March, 1903, a certain weakening of this depression is marked toward the beginning of the summer of 1903; the values for June of that year at Warsaw are relatively quite high. But in July, and in the following months until October the depression very clearly increases up to about 15 per cent.

(*e*) The end of 1903, as likewise the months of January and February, 1904, present anew a large increase in the depression, and the values of intensity observed during these months seem even lower than at the beginning of 1903. Thus the month of February, 1904, gives values diminished by more than 30 per cent. The depression ends in the same month, in a manner as abrupt as its beginning.

8. *Duration of insolation in hours and total quantity of heat in gram calories at Warsaw during the years 1903, 1904, and 1905.*—This profound perturbation in the intensity of solar radiation as it reaches the surface of the earth may have given rise to important meteorological results. The question as to the influence will be of the highest interest and will necessitate special research, altho the problem presents great difficulties and complications. We add that the study of this question has been already begun in an important memoir, by S. P. Langley, published in the Astrophysical Journal.[13]

[13] S. P. Langley. On a possible variation of the solar radiation, and its probable effect on terrestrial temperature. (Astrophysical Journal, vol. 19, pp. 305–321.)

We shall limit ourselves simply to indicating the duration of insolation at Warsaw, and the sums of heat for the three consecutive years 1903, 1904, and 1905. (See Table 3 and Table 4.) The sums of heat have been calculated[14] from combined readings of heliographs [sunshine recorders] and actinometers; they are exprest in gram-calories per square centimeter of horizontal surface.

TABLE 3.—*Duration of insolation at Warsaw.*

Year.	Winter. I, II, XII.	Spring. III, IV, V.	Summer. VI, VII, VIII.	Autumn. IX, X, XI.	Annual.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*
1903	114.9	353.5	462.7	314.3	1245.4
1904	101.7	508.4	849.0	331.5	1790.6
1905	164.9	424.8	754.6	218.6	1562.9

TABLE 4.—*Sums of heat in gram-calories per square centimeter of horizontal surface at Warsaw.*

Year.	Winter. I, II, XII.	Spring. III, IV, V.	Summer. VI, VII, VIII.	Autumn. IX, X, XI.	Annual.
	gr. cal.	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*
1903	1340	10810	17300	7440	36890
1904	930	16190	28960	8150	54230
1905	1910	15760	27790	5460	50920

Taking 3550 hours as the maximum of the possible duration of insolation at Warsaw (which can be registered by heliographs [sunshine recorders] of the Stokes-Campbell type), we find that the actual duration was, in 1903, equal to 35 per cent of the possible maximum duration, while in 1904 there was 50 per cent, and in 1905, 44 per cent of that same possible duration.

The year 1903 presents also a considerable deficiency in respect to the sums of heat, in comparison with the years 1904 and 1905. We find[15] that if the sky were constantly clear the sums in question for the four seasons would be, at Warsaw, 7900, 35,700, 45,000, and 18,200; the total for the whole year would thus be 106,800 gr. cal. per cm.^{2} of horizontal surface. Table 3 shows that in 1903 the ratio of the actual sums received to the theoretical sums is only 35 per cent, whereas in 1904 it is 51 per cent, and in 1905 it is 48 per cent.

THE "SOUTHWEST" OR "WET" CHINOOK.

By H. BUCKINGHAM, sr. Dated Lawton, Okla., March 19, 1907.

In the winter of 1851 I spent a couple of months on Queen *Charlotte Island, off the British American coast, sailing from* Puget Sound on a gold hunting voyage. I think we sailed from the Sound early in January. We went about half-way (I should think) up the island, and entered Gold Harbor (on the west side). We went east about 12 miles to the head of the harbor and anchored for the winter. We prospected for gold for some two months.

On the 30th of March the chinook winds set in and the snow melted with great rapidity. When we entered the island the only snow we saw was on the coast. East of us was a mountain of rock, I should think 30 miles from the head of the bay. It appeared 10,000 feet high, and was bare when we came in sight of it; but in a couple of weeks it was covered with snow.

After the chinook wind, which appeared to come from the southwest—we took it for granted it was the Japan current—had blown for twenty-four hours it seemed as if the water was leaping from every mountain top. The roar of it was something like Niagara, tho not so deep, as the water was scattered, so to speak.

On the 1st of April we raised anchor, and at 4 p. m. were in

[14] We can not here enter into the details of these calculations. See G. 1906. Chap. XI, pp. 167–186.

[15] According to the "mean" monthly values of the intensity in 1901–1905. See G. 1906; Chap. XI, pp. 172–176.

the open sea, bound for Puget Sound. The weather did not seem as warm when we reached the outside, and I do not remember exactly its temperature; but it was not nearly as cold as when we were on the way up, in January.

THE "DRY" CHINOOK IN BRITISH COLUMBIA.

By R. T. Grassham. Dated Keithley Creek, B. C., March 5, 1907.

I am living at a stock ranch in the Bonaparte Valley—which lies about midway between the Cascade and Gold Ranges and the Rocky Mountains—north of Ashcroft, on the line of the Canadian Pacific Railway.[1] Our district is known as the "dry belt". Very little or no rain falls during the spring or summer. We depend upon irrigation for our crops and hay, and my experience of the chinook is as follows:

After having a cold snap of zero weather, with a foot of snow on the flats and hillsides—bright clear weather—there comes a change; heavy dark clouds loom up from the west and southwest, accompanied by a very strong wind—at times one might call it a gale. No matter what the temperature previous to this change (40° below zero, or anything), within a few minutes the air becomes balmy as spring—by contrast it seems hot. I have known the thermometer to rise 59° in five minutes. When we have this wind, one can read in the daily papers of shipping disasters and storms off the Vancouver Island and Washington coasts. Heavy rain and snow [occur] west of the Cascade Mountains, but I find no account of the temperature being so high west of the Cascade Mountains as with us.

As to the dryness, our house lies in the valley. The Cariboo wagon road is some feet above the house, and the ground rises at an angle of 30° to the first hill, then in a series of benches to timber. The curious phenomenon [may be noted] of having one foot of snow as it were *sucked* up from off the ground (the ground being frozen to the depth of several inches). In three or four hours not a vestige of snow may remain, and yet not a trickle of water crosses the road. As the ground is frozen, therefore the idea of absorption in the ground is untenable; the water does not run off.

Is not the air heated by friction, so that the intense dryness of the wind evaporates and absorbs the moisture?

We never have a chinook in winter accompanied by clear weather, but always dark, stormy-looking clouds, and they rarely last more than three days.

We are much interested in these same chinook winds. This winter I have been at Keithley Creek managing an estate. On the flat the snow was 5 feet deep; on the Bonaparte the snow was 18 inches to 2 feet deep; and all cattle had to be fed—a serious item with a big band of cattle. Usually we need only to feed range cattle once in seven years, our fenced-up winter pastures being fully sufficient, except for a few sick cattle. So when we have a heavy fall of snow and zero weather our sole ambition is for a chinook; and there is no doubt whatever when it does come—we never forget the accompanying atmospheric conditions with us at the ranch, or on the seacoast.

* * * * * * *

As a rule the barometer drops when strong winds and rain are coming. Is this because of the denseness of atmospheric pressure, accompanied by the dampness or moisture in the atmosphere?

Do you think the barometer will act the same with a gale of wind accompanied by heavy rain, as with a gale accompanied by the heat of a chinook when a dry atmosphere absorbs the moisture from the snow on the flats and steep hillsides with practically no waste?

THE WET AND DRY CHINOOKS.

The following abstract of correspondence on this subject may interest many teachers and observers:

[1] This description places him in latitude 52° 45′ N., longitude 121° 45′ W., approximately.—Editor.

To the best of my knowledge, the name "chinook" is applied to two very different sorts of winds. I believe it was originally applied to a warm, moist southwest wind at stations near the coasts of Oregon, Washington, and British Columbia, which was supposed to blow from the region where the Chinook Indians lived, or to be in some other way associated with them. Quite independently of this use of the word, it was applied by settlers in the west of Montana to a warm, dry wind descending the Rocky Mountain slope. Some thought that it blew from the chinook region of the Pacific coast, others simply said that it was as warm as the chinook winds of the Pacific coast. However, in some way this application of the name to a warm, dry wind descending the mountain in clear weather has become so general that its original application to a moist, southwest wind has been almost lost sight of.

The discussion in reference to the winds of December 22, 1906, hinges upon the definition of a chinook wind. If it means the wet chinook of the coast of British Columbia, then its temperature and moisture are due to the fact that it has just arrived from the Pacific Ocean, laden with moisture which is condensed into cloud and rain as the wind rises over the coast ranges. The Japan current is too far to the west to have any particular influence on either temperature or moisture. On that particular date, December 22, an area of low pressure was west of Vancouver Island, and, whatever the local winds may have been, there must have been a general movement of the atmosphere from the Pacific west of Oregon northeastward toward British Columbia, and this would of itself bring warm, moist air enough to explain a rise of temperature from 12° F. at 8 a. m. to 43° F. at noon (of the one-hundred and twentieth meridian); in fact this southwest wind blows outward from a great area of high pressure central near the Hawaiian Islands, so that its temperatures come from the Tropics, and not from the Japan current. The influence of the Japan current has been exaggerated in popular estimation by many thoughtless writers as much as the influence of the Gulf Stream on the Atlantic Ocean.

A second alternative explanation has been suggested, namely, that the strong southwest gale from the ocean, blocked in its passage over the mountains, rises and precipitates its moisture as rain or snow; then "the wind being lighter as it ascends higher, with increased velocity, continues eastward, and on the eastern slope descends to the valley with such rapidity that the friction warms it up to the recorded temperature".

This proposed explanation seems to be entirely inadmissible if it is intended to apply to Keithley Creek. I do not see how a southwest gale from the Pacific can be said to have past over a mountain range and descend on the eastern slope to this station, which is located on a small stream flowing out of Cariboo Lake into the Frazer River. A westerly wind will blow up the stream from the ocean and an easterly wind down stream from the neighboring hills and the Rocky Mountains. In addition to these geographical objections to this explanation there is a very important meteorological consideration. A wind is not warmed up by friction as it blows over the ground. If the ground is hot and dry it may receive heat by conduction, but if the ground is damp the moisture will evaporate and the wind will be cooled by that process. A "wind that descends to the valley with rapidity" is not warmed up by friction, but by the compression due to the increasing barometric pressure. When air rises it cools by reason of the work done by expansion, as it comes under lower pressure, precisely as steam escaping from a boiler cools by expansion. On the other hand when air descends it comes under greater pressure, and is comprest and warmed by reason of the work done in compressing it. This warming by compression is to be observed whenever air is comprest by machinery; as, for example, in pumping air into the tire of a bicycle. In such compression, if no moisture is added to the air, then the simple increase in temperature makes the air become relatively drier; or we may say that its relative humidity is diminished, or its capacity for moisture is increased. If the air is slightly foggy at first, then the fog disappears as soon as it is slightly comprest and warmed; consequently a descending, warm, chinook wind is also a dry wind with cloudless sky. In this process we have the natural explanation of the dry chinooks of Montana, and also of similar chinooks when they occur in British Columbia. These dry chinooks frequently occur in California, and I do not see why they might not occasionally occur at Keithley Creek; but in this case they should be easterly or northerly winds descending the Rocky Mountain slope. They would not necessarily be very warm, but would be very dry. Thus in California the cold, dry, descending northeast wind, by reason of its causing rapid evaporation, and by reason of the clear sky and danger from frosts, is liable to do great damage to the delicate vegetation.—*C. A.*

The behavior of the barometer is very different in the dry and the wet chinooks. The latter is a moist southwest wind on the east side of an advancing area of low pressure, and the local barometer falls as the low area approaches. Then there follows the strong, dry northwest wind and the rising barometer on the west side of the low area. These winds are called horizontal, because their average inclination toward the ground is slight, and the cooling by expansion or warming by com-