Results of 15 years of observations published in the Revue des Faux et Forets:

	Oak	Beech	Spruce	Pine	Others
Percentage of trees	11	70	13	6	----------
Trees struck	159	21	20	59	20
Relative frequency	48	1	5	33	----------

Observations in the Bavarian State forests, 1887–1890:

	Oak	Beech	Spruce	Pine	Others
Percentage of trees	1.8	10.8	41.5	30.8	15.1
Trees struck	61	7	155	131	----------
Relative frequency	52	1	6	7	----------

[1] Relative frequencies are based on 1 for the beech, so that during the period covered by the observations 1 beech tree was struck to 60 oaks, 6 spruce, and 37 pine, each kind of tree being assumed to be present in equal numbers.

Other more recent studies confirm in general the above results, which show that the oak is struck much more frequently than other kinds of trees, with the possible exception of the poplar, which does not appear to have been present in the Lippe-Detmold forest. The list of trees also subject to lightning damage includes the elm, ash, and gum, while those least attractive to lightning are the chestnut, maple, alder, and mountain ash. Those intermediate are the apple, cherry, linden, and walnut, but no tree is immune.

As before stated, an unsound tree containing rotted portions is likely to be damaged to a greater extent than a sound tree, or one which has received surgical treatment, which introduces highly conducting metal into the tree in place of the rotted wood with its low conductivity.

The metal cables and rods quite often used in modern tree surgery to protect the trees against wind damage and decay, while serving in a minor way as conductors and furnishing some protection against lightning, can by no means be considered as a substitute for the thorough protection which it is possible to obtain by rodding, a more recent development than tree surgery. The rodding of trees, especially valuable ones, or those which involve the safety of a building or of animals, is now advocated by the Bureau of Standards, the Weather Bureau, the National Board of Fire Underwriters, the Ontario Department of Agriculture, and others.

In this connection the following is quoted from a new bulletin in process of preparation, entitled "Protection Against Lightning of Buildings and Farm Property":

Protection of trees.—If a building is more or less surrounded by high trees, these trees protect the building to quite an extent from lightning. This is especially true of deep-rooted trees, which are more liable to damage than others. Poplars, oaks, pines, elms, ash, etc., are of this kind. But the trees should be considered only as an additional protection to the building, and the customary equipment should be provided for the latter. Large, full-grown trees near a dwelling are valuable as a rule, and if it is desired to protect them against lightning, a few of the higher ones should be rodded as follows:

Place an air terminal in the top of the tree, but not so high as to be insecure, and ground it through one or two down conductors, the number depending upon the size of the tree. Screw fasteners with a long shank are desirable for holding the down conductors in place along the tree trunk in preference to a rigid fastening. One of the grounds provided for the conductors on the building may be used if convenient, or separate ones constructed at the foot of the trees. In order that a lightning discharge shall not damage the root system of the tree protected, it is generally advisable to construct shallow grounds, essentially as described under "stranded-cable grounds." It is realized that the growth of trees will make it difficult at times to maintain the rodding, and its extension, partial renewal, or repair will occasionally be needed, especially on the younger trees, but less so on the older trees, which change but little from year to year and are probably the most valuable and largest of a group and to be rodded in preference to the others. It is our conviction, however, that the additional protection of both trees and adjacent building often makes the trouble and expense worth while.

SOME FEATURES OF THE CLIMATE OF ALASKA [1]

551.58 (798)

By MELVIN B. SUMMERS

[Weather Bureau, Seattle, Wash.]

Less than a generation ago the popular conception of Alaska was that of a land of perpetual ice and snow, infested with polar bears, and inhabited by a race of beings who dwelt in snow and ice houses and subsisted on the blubber and flesh of walrus, seal, and other animals native to a frigid climate. So fixed had this idea become that even to-day, after considerably more than a billion dollars of wealth has been wrested from the Territory through mine, forest, field, and sea, there are those who find difficulty in divorcing these preconceived opinions from their minds.

It is a surprise to many people to learn that tropical daytime temperatures are recorded in Alaska every summer, and that there are parts of the Territory, notably in the Aleutian Islands and along the southern coast, where zero readings have never been observed.

Lying, as it does, north of the Pacific Ocean, with the vast expanse of British America to the east, and separated only by Bering Strait from the larger land mass of Siberia to the west, the main portion of the Territory is covered during the winter by relatively high atmospheric pressure. Over the immediate water surface on the south there usually exists a trough of low pressure with a west-east trend, commonly known as the Aleutian LOW. Through this pressure valley, so to speak, pass a great many of the cyclonic disturbances of the Northern Hemisphere in their west-to-east movement. Other disturbances originate in it and altogether it exercises a great influence on the weather of the Territory as well as on that of the Canadian Provinces to the east and the northern half of the United States to the southeast.

The mountains of British Columbia, with their southeast-northwest trend, present somewhat of a barrier to the eastward movement of these barometric depressions, many of which stagnate in the Gulf of Alaska for days at a time, especially if the Pacific high-pressure area lying to the south manifests a tendency to move northeastward over Oregon and Washington. In fact, after reaching the Gulf of Alaska a cyclonic storm may be forced to pursue a retrograde movement and actually to move northwestward.

Whether from a breaking down of pressure in the Arctic slope of Alaska, or from the northward thrust of the Pacific High, these Aleutian LOWS occasionally take a northeastward movement over Bering Sea and advance toward Seward Peninsula and the Kobuk Valley of Alaska, or they may take a similar direction of movement farther east over the Yukon Valley. So long as the LOWS pursue their normal track over the north Pacific and the Gulf of Alaska, fair and cold weather obtains over the interior valleys of the Territory, with warm and rainy conditions over the southeastern panhandle. When, however, they take a northeastward movement, the temperature of the interior moderates under the influence of southerly winds, and precipitation to a greater or less

[1] Read before the meeting of the American Meteorological Society, Leland Stanford University, June 26, 1924.

extent ensues. Occasionally, from some cause, the Arctic High builds up to an exceptional extent, and then northerly winds, attended by fair and unusually cold weather, prevail over practically the entire Territory, including the usually warm and rainy south-southeastern section.

In the summer season, with the building up of pressure over the cooler waters of the north Pacific and the heating of the land surface of the interior under the influence of the long days of high latitudes, the interior pressure is relatively low and is attended by occasional rains.

With these meteorological conditions in mind as the major weather controls of the Territory, although modified greatly by its diversified relief, a few of the climatic features will be briefly considered. The southeastern or panhandle section will be taken up first.

It should be understood at the outset that this part of Alaska is of unusually strong relief. Mountainous in the extreme, the land areas are cut by innumerable tidewater bays, sounds, inlets, and fiords. Peaks 3,000 feet in height are common, while scores have elevations above 5,000 feet, and a number rise to 10,000 feet or more. Because of its strong relief and also because of its peculiar position with respect to the north Pacific storm track and its close proximity to the ocean itself, this southeastern portion of the Territory receives very heavy precipitation. In fact, at no observation station in the United States proper is the annual precipitation as great as is recorded at several stations at or near sea level in the Panhandle and Prince William Sound districts. Ketchikan, one of the most important commercial centers of the Territory, receives 157 inches annually, including the water equivalent of 40 inches of snowfall. Fortmann Hatchery, near by, receives 148 inches, and Cordova and Latouche, at the entrance of Prince William Sound, 131 and 147 inches, respectively. At Jumbo Mine, at an elevation of 1,500 feet, the total is about 193 inches a year, including approximately 450 inches of snowfall, as indicated by a three-year record.

The effect of increase of altitude on precipitation is indicated clearly in a comparison of the records of Juneau and Perseverance Camp. Although only 3 miles distant from each other, Juneau, at sea level, receives 80 inches a year, while Perseverance Camp, at 1,400 feet and in the lee of a precipitous and narrow mountain range 3,800 feet high and running athwart the moisture-laden southerly winds, receives about 150 inches. Juneau receives these same winds, but not the full effect of the adiabatic cooling incident to the ascent of the mountain. Clouds from which heavy rain is falling on the crest are perceived to continue their precipitation with apparently the same intensity for some distance in their horizontal movement across the valley in which Perseverance Camp is located.

Southeastern Alaska can lay claim to a heavier monthly precipitation than any on record in the United States, except for a few places in the mountains of California. Ketchikan had a total of 53.85 inches and Jumbo Mine, 61.46 inches, in November, 1917.[2]

Because of being so frequently in the eastern quadrant of the north Pacific cyclonic area, the frequency of precipitation also, exceeds that of any part of the United States. Whereas the rainiest portions of Washington, on the seaward slopes of the Olympics and Cascades, receive measurable precipitation on from 175 to 200 days a year, a large portion of southeastern Alaska has from 200 to 240 such days.

Despite the phenomenally large monthly and annual totals, there occur no intense downpours of short duration, such as are common in the central valleys of the States. This fact can be explained by the absence of convectional thunderstorms. At Juneau, with its annual precipitation of 80 inches and a maximum 24-hour fall of 5.54 inches, the maximum 15-minute fall is 0.28 inch, and the maximum hourly fall, 0.56 inch.

The economic importance of the heavy precipitation of southeastern Alaska may well be mentioned here. The extremely rugged topography of the country lends itself readily to the creation of storage reservoirs whereby the abundant precipitation can be utilized in the development of hydroelectric power. Already every town of importance is deriving light and power from this source, including a large gold-mining operation at Juneau, handling 8,000 tons of rock a day. Numerous other sites, some of them of large possibilities, have been surveyed and await the development of the vast timber and mineral resources with which the country is endowed.

However, it should not be inferred from the frequency and quantity of rainfall in the panhandle of Alaska that the air is always moisture laden, for, with a pressure distribution that induces northeasterly winds, blowing from the comparatively dry interior of British America, there comes a marked decrease in both the absolute and relative humidity, the latter being reduced still further by the adiabatic heating incident to the descent of the air from the mountain crests. A relative humidity of 12 per cent has been recorded at Juneau under such conditions. While these cases of extreme dryness are comparatively few, they nevertheless may create a forest fire-hazard in cut-over lands when they do occur, especially in the spring of the year, when the preceding year's growth of ferns and other vegetation has not yet been covered over and kept damp by the new growth.

As a corollary of the heavy precipitation may be mentioned the moderate temperatures that prevail in that region. At Juneau, with a January mean of 27° and a July mean of 57°, there is an average of only 108 days a year with freezing temperatures and at Sitka only 106, as against 186 days at Bismarck and 109 at Chicago. Zero readings occur less than twice a year at Juneau, on the average, and less than once a year at Sitka.

In the interior of the Territory, as exemplified by the great Yukon Valley, the outstanding features of the climate are the great annual range in temperature and the comparatively light precipitation. Separated from the Gulf of Alaska by the high mountain barriers of the Alaska range, the climate here, especially in the upper valley, is continental in the extreme. At Fort Yukon, on the Arctic Circle, the range between the January and July means is 89° and at Fairbanks, 76°, as against 71° at Pembina, N. Dak., which is generally considered as being one of the coldest places in the United States. The absolute range in temperature at Fort Yukon is 170°, at Fairbanks, 164°; and at Pembina, 155°.

The summer temperatures of the interior are delightfully pleasant, and, under the effect of the prolonged daylight, vegetation makes rapid growth. Temperatures of 70° and above occur on an average of only 13 days each summer in the lower Kuskokwim Valley, where the cooling influence of Bering Sea is manifest to some extent, but at Fairbanks the number of such days is increased to 61. In the Tanana and upper Yukon Valleys temperatures in excess of 90° are occasionally recorded. While freezing may occur in any of the summer months, except where there is good air drainage, such temperatures are usually of short duration and do little or no damage.

[2] In January, 1909, at Helen mine, California, 71.54 inches were recorded, and other points received more than 53.85 inches.

While the number of days a year with zero temperatures range from 61 in the Matanuska Valley to 123 at Fairbanks and 159 at Fort Yukon, such low readings do not persist throughout the winter, as is popularly supposed. That prolonged extreme cold may occur, however, is evidenced by the fact that in the winter of 1917–18 zero temperatures prevailed continuously in the upper Yukon Valley from November 23 to January 3, with a mean temperature for December at Eagle of −45.8° and a departure from the normal of −34.6°. At Dawson, Yukon Territory, the mean for December was −51.3°. Subnormal temperatures prevailed throughout the Territory during that month, except in the Aleutian region, under the influence of pressure that was half an inch above normal along the sixty-fifth parallel. In contrast to this abnormally cold December may be cited the same month three years previous, when the mean at Eagle was 7.8°, or 19.0 above normal, thus making a range in mean temperature for the month of 53.6°, as against a similar maximum range of the monthly means at Bismarck, N. Dak., of 33.6°.

The precipitation ranges from about 19 inches in the lower Yukon to about 12 inches in the middle Yukon and lower Tanana Valleys, but this shades off with recession from the sea until at Fort Yukon the total is less than 8 inches. The four months from June to September receive over half the year's precipitation—a condition most propitious for agriculture and placer mining. Thunderstorms are common during the summer months, but they are usually mild in character and are seldom attended by heavy hail.

As an illustration of the possibilities of agriculture in some of the interior valleys, it may be said that in the Fairbanks district, where spring wheat, oats, potatoes and other vegetables, and small fruits are successfully grown, there has been only one serious crop failure in the 19 years since farming was begun in that district. This was in 1922, when a killing frost on August 29 destroyed practically all crops. These had been unusually late in maturing because of a late spring and an unusually cloudy and wet summer.

The variability of the climate of the Territory from year to year is disclosed in a study of the records of five representative stations: Sitka and Fortmann Hatchery, in the southeast; Eagle and Fairbanks, in the interior; and Nome, on the northern Bering Sea coast. For the purpose of this study the calendar year was disregarded, and annual means were computed for the coldest and warmest periods of 12 consecutive months. Grouping the months in this way, it is found that at Eagle the coldest year had a mean that was 5.6° below normal, and the warmest year, 6.4° above. This does not differ materially from the record at Bismarck, where the maximum departures are −5.2° and +5.8°. The comparative uniformity of the coastal climate is exemplified by the Sitka record, which shows the coldest year to have been 2.4° below normal and the warmest, 3.7° above. At Seattle the maximum departures are −2.1° and +2.5°.

During the last 20 years, the calendar years 1905, 1912, 1914, 1915, and 1923 were decidedly above normal in temperature throughout the Territory from the Arctic Circle southward, while the years 1909, 1910, and 1917 were decidedly below normal. These departures from average temperatures are reflected in the records of Seattle, though in lesser degree, and, with two exceptions, at Bismarck.

The variability of precipitation from year to year likewise is greatest in the interior. Here, at Fairbanks and Eagle, with normals of approximately 10 and 12 inches, their wettest consecutive 12 months show excesses of 99 and 53 per cent, respectively, and the driest ones deficiencies of 39 and 37 per cent. At Nome, near the western extremity of continental Alaska, there has been an excess of 79 per cent and a deficiency of 58 per cent on an annual normal of 17 inches. At all three of these stations the precipitation is a factor in placer mining, and at Fairbanks in agriculture as well. The records at each station show the minimum 12-month totals to be sufficiently below the normal to interfere with, although not necessarily to suspend, operations along those lines.

In the southeastern portion of the Territory, as shown by the Fortmann Hatchery and Sitka records, the wettest 12-month periods were 28 per cent above the normal in quantity at both stations, although the normals differ by 64 inches, being 148 and 84 inches, respectively, for the period under consideration The driest 12-month periods show deficiencies of 28 per cent at Fortmann Hatchery and 29 per cent at Sitka. These figures show a probability of a fairly uniform supply of water for power purposes, although marked deficiencies for several consecutive months indicate the wisdom of providing storage facilities when practicable.

A comparison of these maximum and minimum departures from normal precipitation with similar data in the States shows the Alaskan climate in a favorable light. At Bismarck, with a typical continental climate, the excess of the wettest 12-month period is 87 per cent, and the deficiency of the driest, 55 per cent, with a normal of 17 inches. At Seattle, under considerable marine influence, the excess is 45 per cent and the deficiency 37 per cent, with a normal of 34 inches. Much greater departures from normal conditions than any of those enumerated above are found in the records of many stations on the Pacific slope, particularly in California.

In conclusion, it may be said that while the climate of Alaska presents great contrasts and in some sections is quite rigorous at times, it is healthful and invigorating. The economic development that has already taken place in the Territory has been achieved largely through the aid of climatic conditions, rather than in spite of them, as is sometimes contended. As an example, the overland transportation of supplies, machinery, etc., for mining and other development work, would be impossible in a climate with winter temperatures above freezing, without the building of expensive roads and bridges. Modern tractors now draw great loads across frozen streams, bogs, and tundra to remote districts, with but little previous preparation of roads and trails. The excessive precipitation of southeastern Alaska has fostered the development of the vast mineral and timber resources of that district by making available an abundance of cheap hydroelectric power. Even the great fur-seal industry of the Pribilof Islands is largely dependent for its success on the excessive amount of cloudy and foggy weather that prevails there during the seal-taking season, since the driving of the seals to slaughter can not be accomplished during periods of sunshine without an overheating of the animals and a lowering of the quality of the fur.

Given the necessary resources and favorable economic conditions, there is nothing in the climate of Alaska that should prevent the Territory from ultimately becoming a mighty empire among the States of the Union.

Extremes of mean temperature for periods of 12 consecutive months at representative Alaskan stations and at Seattle, Wash., and Bismarck, N. Dak.

Stations	Years of record	Normal	Coldest 12-month period			Warmest 12-month period		
			Date	Mean	Departure from normal	Date	Mean	Departure from normal
		°F.		°F.			°F.	
Eagle	17	23.8	July, 1917–June, 1918	18.2	−5.6	October, 1914–September, 1915.	30.2	+6.4
Fairbanks	18	25.5	July, 1917–June, 1918	21.1	−4.4	do	31.0	+5.5
Nome	17	25.2	January, 1920–December, 1920.	21.2	−4.0	January, 1912–December, 1912.	29.5	+4.3
Sitka	24	43.7	October, 1903–September, 1904.	41.3	−2.4	October, 1914–September, 1915.	47.4	+3.7
Fortmann Hatchery.	19	42.8	January, 1909–December, 1909.	38.9	−3.9	January, 1915–December, 1915.	46.6	+3.8
Seattle	32	51.3	January, 1916-December, 1916.	49.2	−2.1	January, 1892–December, 1892.	53.8	+2.5
Bismarck	49	40.5	December, 1874–November, 1875.	35.3	−5.2	December, 1877–November, 1878.	46.3	+5.8

Extremes of precipitation totals for periods of 12 consecutive months at representative Alaskan stations and at Seattle, Wash., and Bismarck, N. Dak.

Stations	Years of record	Normal	Wettest 12-month period			Driest 12-month period		
			Date	Total	Per cent of normal	Date	Total	Per cent of normal
		Ins.		Ins.			Ins.	
Eagle	17	9.87	July, 1910–June, 1911	15.13	153	March, 1920–February, 1921.	6.22	63
Fairbanks.	18	11.88	November, 1906–October, 1907.	23.59	197	April, 1908–March, 1909.	7.28	61
Nome	17	17.37	December, 1921–November, 1922.	31.14	179	September, 1908–August, 1909.	7.33	42
Sitka	24	84.08	February, 1918–January, 1919.	107.58	128	October, 1902–September, 1903.	59.58	71
Fortmann Hatchery.	19	148.06	November, 1905–October, 1906.	188.88	128	June, 1919–May, 1920	107.05	72
Seattle	32	33.43	April, 1893–March, 1894.	48.39	145	December, 1910–November, 1911.	21.01	63
Bismarck	49	16.99	February, 1876–January, 1877.	31.78	187	June, 1889–July, 1890	7.70	45

ON THE APPLICATION OF THE FRONTAL THEORY TO CYCLONES IN THE SAHARA

551.515(661)

By M. L. PETITJEAN

(Comptes Rendus, 179, No. 1, July 7, 1924, pp. 64–65)

[Translated by B. M. Varney, Weather Bureau]

The thermal discontinuity between winds of Mediterranean and of tropical origin in northern Africa reveals the existence, especially in the warmer months, of a special front,[1] which seems to be related to that of the Trade Winds.[2] It delimits the warm and the cold sectors of depressions, the centers of which, at the time of their appearance on the synoptic charts, occupy extreme sourthern Morocco, and the direction of movement of which is confined to either SW.–NE. or W.–E.

The warm sector is at first limited on its western side by the High Atlas of Morocco; it extends toward the north and follows in its course the Saharan chain of the Atlas. On the eastern side its boundary is prolonged as far as southern Tunis. The layer of southerly winds. * * * extends to a higher altitude the greater is the heating in the tropical regions. It rises above the winds from the sea [these constituting the cold sector of the cyclone.—*Ed.*], and its progress northward can be traced from one station by the gradual lowering of its under side, as shown by pilot balloon soundings at military meteorological stations in Algeria and the Sahara.

While maintaining itself in general parallel to the orientation of the Atlas, the front of discontinuity oscillates, with variable amplitude and variable period, as a result of the conflict between the tropical and Mediterranean winds. This is made clear by tracing the lines of synchronous rainfall in connection with the stormy periods which accompany the passage of depressions originating in the Sahara. These lines give way, sometimes toward the north and sometimes toward the south, depending on whether the energy of the tropical winds or that of the winds from the sea is predominant. These alternating advances and retreats are the cause of a succession of very characteristic squalls. When the cold winds finally become dominant they gradually displace the layer of warm winds. Cloudiness decreases continuously and slowly, for the slope of the surface of discontinuity is very slight (a few mm. only), whereupon fine weather succeeds the stormy period.

The topography of north Africa influences the position of the surface of discontinuity as long as that surface passes above the crest of the Atlas Range, the tropical winds rise freely along it. But when, by reason of its shift in position, it is cut by the opposing slope, a foehn effect is produced which gives rise on the opposite side [north side] to a violent sirocco. After having expanded adiabatically during its ascent, the air finds itself after descent at a higher temperature as the result of adiabatic heating due to compression, this heating acting in addition to the gain of heat induced by condensation of water vapor during the ascent.

North of the Atlas the warm air is again forced up, this time above the ocean winds. This double ascent is revealed by the isochrones of rain occurring on the two sides of the mountainous massif.

The warm sector of Saharan depressions usually remains open toward the south side, but it may, as is the case with depressions in the Temperate Zone, be "cut off," either as a result of the arrival of colder air at its rear or of the weakening of the tropical flow. A second depression is thus produced following the first and may in its turn be cut off. It is not rare to discover on the charts of the meteorological service of Algeria cyclone families made up of three of these depressions in a string, lying essentially parallel to the trend of the Atlas.

[1] Petitjean, L., Surfaces de discontinuité en Algerie et au Sahara. (Cahiers du Service Météorologique d'Algerie, 1923, No. 1, p. 13.)

[2] Bjerknes, V., On the dynamics of the circular vortex, with applications to the atmosphere and atmospheric vortex and wave motions. (Geofysiske Publikationer Kristiania, 2, No. 4, 1921, pp. 62–63.)

551.515(262.3)

SECONDARY DEPRESSIONS IN THE ADRIATIC SEA

By FILIPPO EREDIA

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[Translated by B. M. Varney, Weather Bureau]

Sometimes, over the Adriatic appear barometric depressions which, as soon as they are formed, move rapidly in a direction from Northeast to southwest, gradually changing their course by turning toward the south when they reach Sicily or Tripoli. Rarely do they take a course toward the southeast, crossing the Ionian Sea to the Cyrenian Sea. These depressions, believed by most scientists to originate over the Tyrrhenian Sea, present very different characters from those of other depressions in the Mediterranean Basin.