Recent Temperature and Precipitation Fluctuations along the British Columbia Coast

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ABSTRACT

Five-year running averages of mean annual temperature and total annual precipitation are shown for selected British Columbia coast stations. Similar averages of mean seasonal and annual temperature and total seasonal and annual precipitation are also shown for Agassiz, British Columbia.

A general rising trend in mean annual temperature of not more than 2F over the 50-year period beginning about 1900 is found for the British Columbia coast. This rising trend is most pronounced in autumn and winter and least evident in spring and summer. There is some evidence that the trend may recently have begun to level off or may have ended.

No significant decrease or increase in total annual precipitation has occurred over the British Columbia coast during the past half-century, although summer precipitation along the southern section seems to have been somewhat lower during the second quarter of this century than it was during the first.

1. Introduction

Many articles in recent years have dealt with climatic change and variation. Many of these indicate a general warming trend, at least in the northern hemisphere, over the past century or half-century. There is not enough evidence as yet to indicate whether this warming trend is still in progress. According to Willett (1950) there has been a pronounced upward trend in mean annual world-wide temperature since 1885, averaging 2.2F in winter and 1.0F on an annual basis, with the rising trend most pronounced in the higher middle (and especially the polar) latitudes of the northern hemisphere. His study, however, ends with the year 1940. Manley (1953) correlated climatic change across the Atlantic Ocean and states that the recent minor amelioration since about 1925 appears more likely to be ending, or have ended, than otherwise. Mitchell (1961) shows that the great warming trend from 1880 to 1948 has been followed by a cooling since about 1940, although this cooling trend has not yet continued long enough to have definite statistical significance as a world-wide phenomenon. The leveling trend in recent years seems to be common to all of Western Canada according to graphs in Longley (1953), dealing with temperature trends across Canada as a whole. Two papers concerning recent glacial changes in the mountains of the Pacific Northwest are of interest in this connection. Bengtson and Harrison (1954) pointed out that a survey made in 1954 on glaciers of the Cascade Mountains of Oregon and Washington indicates that snowfall was heavier and lasted longer than earlier, and that glaciers on Mt. Rainier and Mt. Baker were advancing and thickening (having advanced continuously since 1949). Hubley (1956) states that of 73 glaciers in the Olympic and Cascade Mountains of Washington, 50 advanced in the 5-yr period, 1950–55, and 22 of the remainder have probably increased in thickness, with the growth starting in 1943.

Articles treating precipitation fluctuations are not as numerous as those treating temperature trends, but there does not seem to have been a significant increase or decrease in total annual precipitation taking the world as a whole.

The purpose of this paper is to report on an investigation of recent variations of temperature and precipitation along the British Columbia coast, and to examine these variations in the content of various recent studies of world-wide climatic change.

Most of the data used were taken from abstracted climatic data from the Head Office of the Meteorological Service of Canada in Toronto.

2. Method

Five-year running averages of mean annual temperature are plotted in Fig. 2 for five British Columbia coast stations (Victoria, Alberni, New Westminster, Prince Rupert and Masset), while 5-yr running averages of total annual precipitation are shown in Fig. 4 (for New Westminster, Agassiz, Mill Bay, Victoria and Massett). Seasonal variations are examined in comparison with annual variations at Agassiz in Figs. 3 and 5, as this station has a long unbroken climatological record in a rural setting. Following common practice, the months of December, January and February are considered the winter season; March, April and May, spring; June, July and August, summer; September,

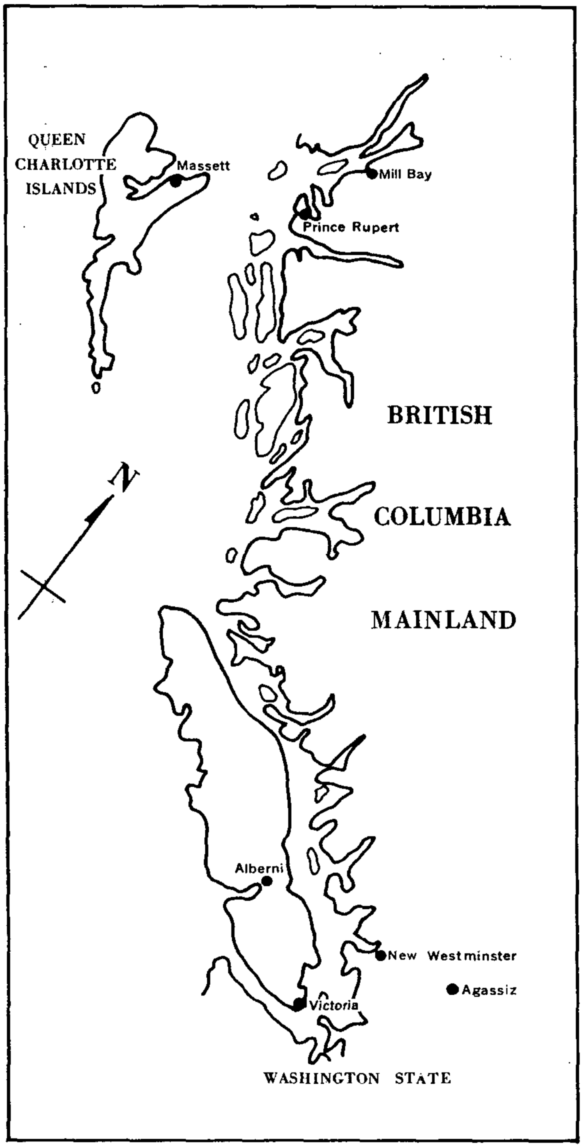

FIG. 1. Location of stations.

October and November, autumn; and for convenience, the annual value is the sum of the four seasons, thus totalled from December to November.

Fig. 1. shows the locations of the stations used, whose co-ordinates and elevations are given in the Appendix. The stations were chosen for their long unbroken records, but whether small changes from time to time in their locations have significantly affected the results would be difficult to determine, particularly in the cases of the more northerly ones where, during the early years of record, there is almost a total lack of surrounding stations with which comparison of data may be made.

3. Results

From at least the beginning of the present century down to the early forties, there was a general rise in mean annual temperature along the British Columbia coast. This increase shows up at all stations except Alberni, and its magnitude is estimated at not more than 2F per half-century. Judging from the seasonal curves plotted for Agassiz, the rising trend is most pronounced in autumn and winter and least evident in spring and summer. Inspection of the curves for all stations indicates that the rising trend noticeable at most of the stations early in the century may have ended or begun to level off, and it is interesting to note that this effect shows up in the case of all seasonal curves for Agassiz.

Four stations show major irregular fluctuations with a period of 15 to 20 years between successive maxima or minima. The major exception is Massett. This station is located in the Queen Charlotte Islands, well off the British Columbia coast, and its climate is much more "maritime" than that of the mainland, as it misses the cold outbreaks in winter and warm spells in summer to the degree experienced at the other stations. In the case of the seasonal curves for Agassiz, they are in general more irregular than the annual curve, and it is harder to identify the general 15- to 20-yr period. The maxima in the seasonal curves show up somewhat better than do the minima, and it is interesting to note that the most pronounced maxima in the annual curve (near the mid-twenties and about 1940) occur when the seasonal maxima are in phase.

There is little if any evidence to indicate that precipitation has appreciably increased or decreased over the past half-century along the British Columbia coast, as major fluctuations seem to be more significant than long-term trends. Judging from the Agassiz record, however, summer precipitation seems to be slightly lower during the last half of the period of record. Curves for most of the stations show some quasi-cyclic regularity, especially in the case of Victoria, but as in the temperature curves Masset is noticeably different from the others. Except for a minor decrease in the last two decades, little variation in annual precipitation has occurred at Masset since 1915. Its geographical location is such that instead of having a pronounced dry season in summer and a very wet season in winter (as is the case at most British Columbia coastal stations), Masset has no dry season in summer and only a moderately wet winter season.

In the cases of the annual precipitation curves, there does appear to be a major irregular fluctuation with a period of 10 to 20 years between successive maxima or minima. This rhythm does not appear in the seasonal curves for Agassiz to any extent; however, the maximum shown on the annual curve toward the end of the decade

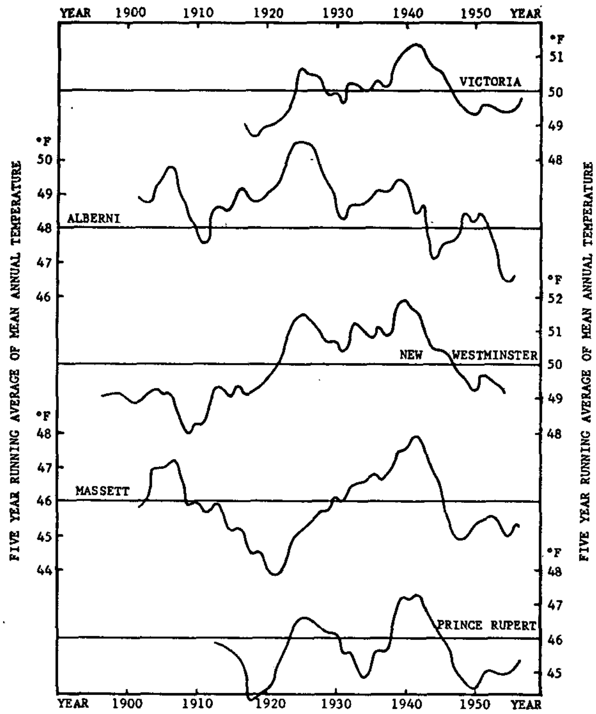

FIG. 2. Five-year running averages of mean annual temperature for selected British Columbia coastal stations. The five year running averages are credited to the middle year.

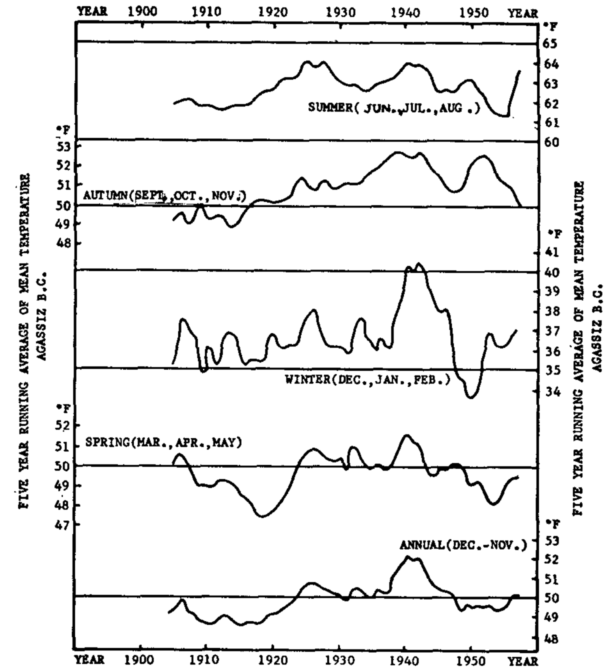

FIG. 3. Five-year running averages of mean seasonal and annual temperature at Agassiz, British Columbia. The five year running averages are credited to the middle year.

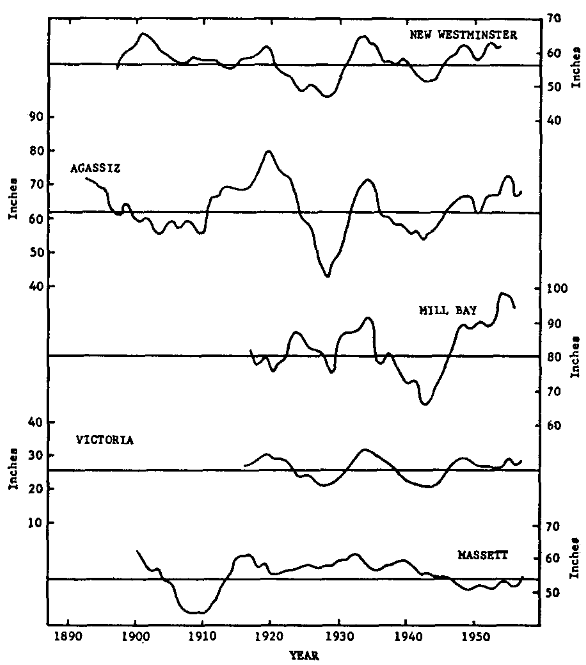

FIG. 4. Five-year running averages of total annual precipitation for selected British Columbia coastal stations. The five year running averages are credited to the middle year.

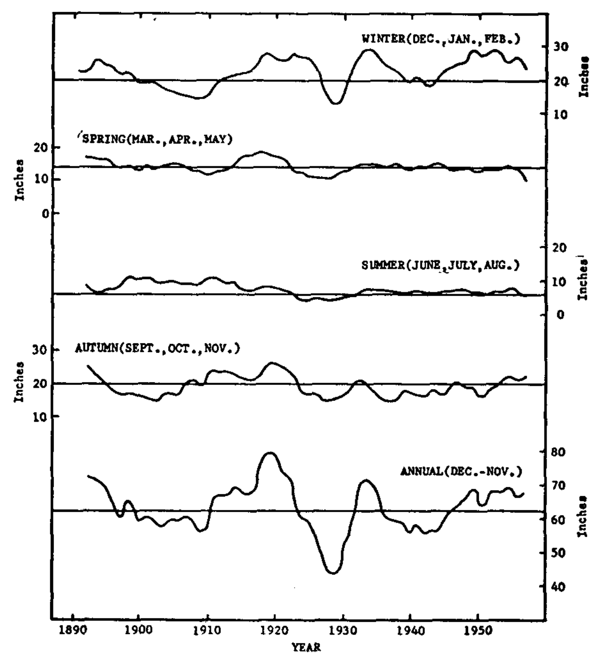

FIG. 5. Five-year running averages of total seasonal and annual precipitation at Agassiz, British Columbia. The five year running averages are credited to the middle year.

1911–1920 appears in all seasonal curves, while each of the curves also shows a minimum in the late 1920's.

A comparison of the rhythm of the temperature and precipitaton shows a systematic inverse phase relationship in both the annual and seasonal curves, although it shows up rather poorly in the cases of the spring and summer curves for Agassiz. In other words, periods of cold years or seasons tend to be correlated with above normal precipitation, while periods of relatively warm years or seasons tend to be associated with below normal precipitation.

4. Comments

The British Columbia coast seems to have shared in the world-wide rise in temperature that has taken place during the first half of this century, and also in the recent decline that has taken place over much of the world since about 1940. There is no reason, however, why climate trends along the British Columbia coast should follow average world-wide trends, as according to Mitchell (1961), changes of average global temperatures are not necessarily associated with preferred geographical modes of temperature change. Incidentally, the reversal in the long-term warming trend which shows up in these British Columbia records in the past decade corresponds with a very striking cooling trend over this period that has taken place over most of Western Canada and particularly Northwestern Canada and Alaska. This sharp cooling trend is indicated by Longley (1953), and by Mitchell (1961), the latter showing the center of the large negative anomaly to be over the Yukon. Most of this large negative annual anomaly is attributed to changes in circulation during the winter months which favor more persistent and, probably more important, colder outbreaks of Arctic air than normal. It is easy to see how winter temperatures and therefore mean annual temperatures over the British Columbia coast would be lowered owing to this change of circulation pattern, but it is not readily apparent why summer temperatures as indicated by the Agassiz record also show this falling off during the last decade.

Any assessment of precipitation trends is more difficult than that of temperature trends, as annual and seasonal precipitation totals are more variable than mean annual and seasonal temperature, both in time and space. At first glance, it would appear that total precipitation over the globe averaged over a number of years would have to be relatively constant, as, if this were not the case, the level of the oceans would be much more variable than it actually is. This assumption, however, would not preclude the possibility that rather large regional changes in precipitation occur in response to long-term changes in mean circulation. Indeed, most recent literature on the subject indicates that comparatively large regional changes in precipitation have occurred in certain key areas of the globe, particularly in tropical and east coast mid-latitude regimes according to Kraus (1955, 1960). As is shown by the results in this paper, however, no significant increase or decrease in precipitation has taken place along the British Columbia coast, possibly because this coastal area lies firmly entrenched in what might be described as the prevailing mid-latitude westerlies, and any reasonable northward or southward drift in the average position of these westerlies would not be enough to put it out of the westerlies regime. Of course, this speculation does not take into consideration the effect of an increase in the average speed of the westerlies.

The possibility that summer precipitation has lowered somewhat at Agassiz raises an interesting point. In summer, the average position of the Hawaiian-Californian sub-tropical high pressure area is well to the north of its winter position, while the Aleutian low is less intense than in winter. As a result the southern British Columbia coastal area is normally on the southern border of the mean westerlies, so that any significant long-term northward drift in the mean position of the westerlies would be bound to decrease average summer rainfall. Precipitation is relatively so much heavier in winter that this summer effect would not appear in long-term annual totals.

The 10- to 20-yr rhythms in temperature and precipitation are not unusual in themselves, as rhythms of this order are common to climatological tabulations over most of the world. The inverse phase relationship, however, is interesting, but the reason for this effect is not readily apparent.

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APPENDIX

Coordinates and elevations of stations

Station	Latitude (° ′ N)	Longitude (° ′ W)	Elevation (ft)
Agassiz	49 14	121 46	52
Alberni (Beaver Creek)[1]	49 16	124 49	300
New Westminster	49 13	122 54	330
Massett[2]	54 02	132 08	10
Mill Bay[3]	55 00	129 45	10
Prince Rupert[4]	54 17	130 23	170
Victoria (Gonzales)[5]	48 25	123 19	228

[1] Present elevation given. Previous value was 250′. Also previous determination of latitude given as 49°15′N.

[2] Former values were published as 53°58′N, 132°09′W.

[3] Originally longitude was published probably incorrectly as 130°00′W.

[4] Location of station has been changed several times: 1911–1920: 54°18′N, 130°18′W, in city, elev. 170′; 1920–1921: 54°18′N, 130°18′W, in city, elev. 100′; 1922 on: 54°17′N, 130°23′W, on Digby Island, elev. 170′.

[5] Station at Gonzales Observatory. Originally latitude was published incorrectly as 48°24′N.

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