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WEATHER PATTERNS & WILDLAND FIRE IN
BANFF NATIONAL PARK

Kenneth A. Baker,
March, 1984.

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Readers Note: This is a technical working report
that will be subject to revision.

PREFACE AND ACKNOWLEDGEMENTS

The combination of relatively good fire history and climatological information for the Banff area provides an excellent basis for the analysis of weather patterns influence on wildland fire in the Canadian Rocky Mountains. The material for this report is the result of the calculation of historic Canadian Forest Fire Danger Rating indices by Seasonal Park Warden John Kellas, and the analysis of historic weather maps by Ken Baker during a voluntary services project. Ken later prepared the final report under contract to Parks Canada. Additional assistance to the project was given by M. E. Alexander (Canadian Forestry Service), Don Tolhurst and Ralph Martinson (Atmospheric Environment Service, Banff), the Archives of the Canadian Rockies, P. A. Baker, Thomas Owen, Rev Trim, Sheryl Hegott and Moe Vroom.

A useful companion volume to this report is A History of Wildland Fire in Banff National Park 1880-1980 (White 1984) which describes the locations and behavior of Banff Fires.

Cliff White,
Vegetation Resources Ward
Banff National Park.

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INTRODUCTION

"Weather conditions on the day of the fire play a vital role in determining fire spread and behavior".

Biotak 1980

"Consideration of weather and climate is absolutely essential to intelligent fire management planning and operation".

Street & Alexander
1980

The above statements are irrefutable. In Banff, as in many places where fire occurs, local climate and current weather are possibly the most influential factors in determining escape fire behavior and final size. Acknowledging that wildfire is by far the greatest natural disturbance in Banff National Park, and that under the right conditions, could prove devastating to the Banff community amplifies the importance for understanding severe fire weather conditions. As Banff National Park accelerates into an era of fire management rather than suppression an understanding of fire weather becomes of critical importance to fire management personnel. The intent of this analysis is to document weather characteristics and/or phenomena that have, in the past, influenced the ignition, behavior and cessation of wildfires in Banff National Park.

STUDY AREA DESCRIPTION

Banff National Park boundaries encompass an area in the Canadian Rocky Mountains of 6,640.7 square kilometres. Approximately 40% of this area is barren rock or permanently covered by snow and ice. This, therefore, leaves 3,984.4 square kilometres that is potentially susceptible to wildfire influences. This fire susceptible area is divided into many

unique compartments by some of the best fuel breaks known to man. These are barren, rocky, mountain slopes. Tree line altitude varies depending on aspect and topography but in general occurs at approximately 2,200 m. Below this level topography generates some of the best fuel ladders known to man. These tree covered slopes vary from a few degrees to vertical. The aspect of these slopes also varies from 0° to 360° .

These tree covered slopes can then be subdivided into three basic forest types. They are: montane, lower subalpine, upper subalpine (White 1982).

The montane type, composing 2% of the park area, is characterized by the presence of Douglas fir (*Pseudotsuga menziesii*) and Trembling aspen (*Populus tremuloides*). Sites in this region vary from extremely dry to mesic. This type of the three discussed, is the most frequently affected by wildfire. Fire intensities are generally moderate and depend on site specifics. The lower subalpine, second type, comprises 25% of the park area and is characterized by the presence of Lodgepole pine (*Pinus contorta*) and varying amounts of Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and Alpine larch (*Larix lyallii*). This type is often extremely dry, dense and continuous but may also, at maturity, be spacious and moist depending on site and the last disturbance by fire. Fire intensity is often moderate but may be extreme depending on weather. Return frequency in this type is less than that of the montane type. The third type, upper subalpine, is characterized by Engelmann spruce, subalpine fir and an assortment of dwarf shrubs. Fire frequency is very low in this type but isolated pockets burn as a result of lower subalpine fire burning into upper subalpine types.

The climate of Banff National Park is a very complex one due to the extreme variations in topography over short horizontal distances. It is essential to understand some important physiographic features of the park in order to comprehend their effects on climate. All of the park lies within the Rocky Mountains on the east side of the Continental

Divide. As a result, rainshadow effect increases toward the eastern boundary. Precipitation is also greatly affected by altitude. The areas of highest precipitation are typically the areas of highest elevation with some areas receiving in excess of 203 cm. precipitation in the year. At lower elevations and particularly in the Bow and North Saskatchewan Valleys yearly precipitation is only 50 cm. It is also important to realize that elevation differences of 1,500 m. in 1.5 km. is not uncommon. Temperature regimes follow the same type of fluctuations as moisture regimes. As a result, humidity and moisture content of fuels can vary tremendously over very short distances.

Another important physiographic feature to conceptualize is the orientation of the mountains. The Rocky Mountains are made up of several ranges oriented on a northwest-southeast axis. This orientation is often at right angles to the prevailing wind directions at 500+ mb heights. Below this level (approximately 5,500 m.) winds are subjected to increasing effects by topography with decreasing altitudes. Winds at the surface are from the southwest 44% of the time during the period May 1 to August 31 (Banff ES data). The strongest winds on the average also come from the southwest (8.6 km/hr) throughout the summer. Statistically, the combination of prominent wind direction and speed and mountain orientation result in fires that burn toward the north in the valley bottoms. The probability of fires burning south in any valley is approximately 1/2 of the probability the fire will burn north. This southward burn probability is based on winds coming from the northwest, north or northeast, not just one wind direction.

Another essential physiographically related element of the climate is related to the coming of spring. Logically since temperatures decrease and precipitation increase with altitude, spring breakup takes longer at higher elevations. This results in having a lid or barrier to fire spread in early spring. Typically valley bottoms are the first free of snow and are therefore subjected to the first drying cycles and have the longest fire season. In many subalpine areas fire danger may be non-existent in the middle of June whereas montane areas in the valley bottoms may be experiencing extreme fire danger. It is

also important to realize that fall and winter and thereby decreased fire hazard comes first to subalpine regions and lastly to montane regions. As a result of this fact and in conjunction with man's desires to seek habitat in the least severe climates he has chosen the areas of greatest possible fire hazard in Banff National Park.

A few other climatic controls need to be mentioned. The effects of latitude chiefly control the amount and seasonal distribution of solar energy (Janz and Starr, 1977). This factor controls our seasons and puts limitations on the fire season. The park's latitudinal location also determines effects by principle cyclonic and anticyclonic pathways. Another physiographic trait worth mentioning is the park's location on the continent. Since the park is not located near any large bodies of water it has a primarily continental climate. That is, the area is subjected to frequent diurnal fluctuations in temperature. Although maritime air masses have some influence on the park region, several major mountain ranges lie between Banff Park and the Pacific Ocean. These ranges moderate the effects of maritime air masses on Banff climate. The park's proximity to the prairies results in influence of continental air masses in both winter and summer. However, the front ranges of the Rockies lying to the east of park boundaries also moderate the influence of continental air masses on the Banff climate. Only the most intense of these systems impregnate the entire park. Weaker systems only affect the main valley bottoms.

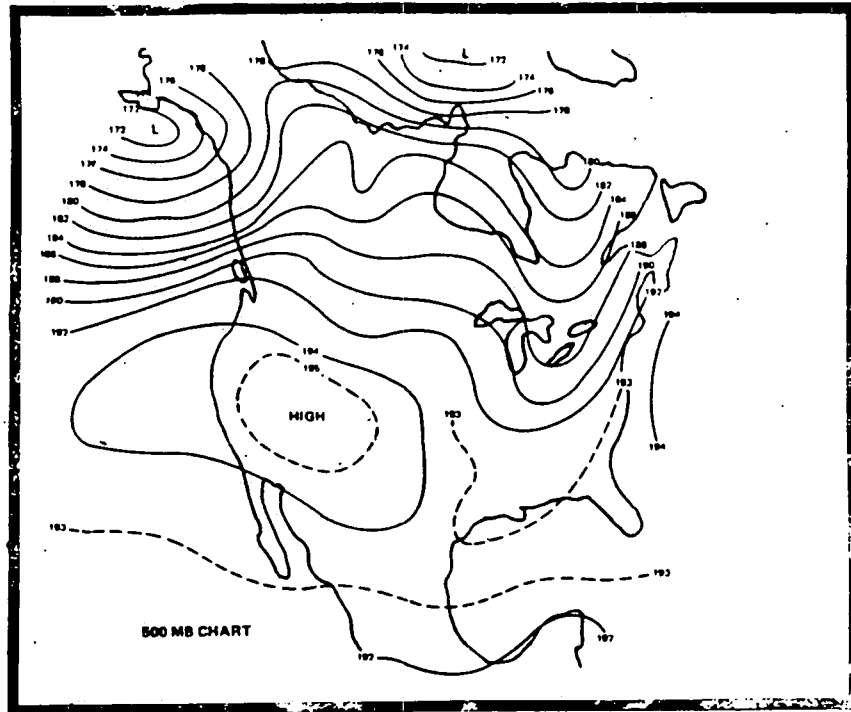
A number of major synoptic patterns or air masses have a prominent effect on the weather which occurs in Banff. Schroeder and Buck (1970) have identified six such patterns which can have a very influential effect on fire danger and behavior. A brief explanation of each follows.

1. Upper Ridge - This situation illustrated in Map # 1 often contributes to the production of extreme fire danger. Also known as an "Omega Blocking High" it prevents cyclonic disturbances from affecting the area within its boundaries. It promotes the influx of hot, dry air into regions within its boundaries that normally remain further south, thereby causing extreme drying in regions not

normally affected by such synoptic patterns. Lately the breakdown of such ridges have been linked to the occurrence of extreme fire behavior (Nimchuck 1983).

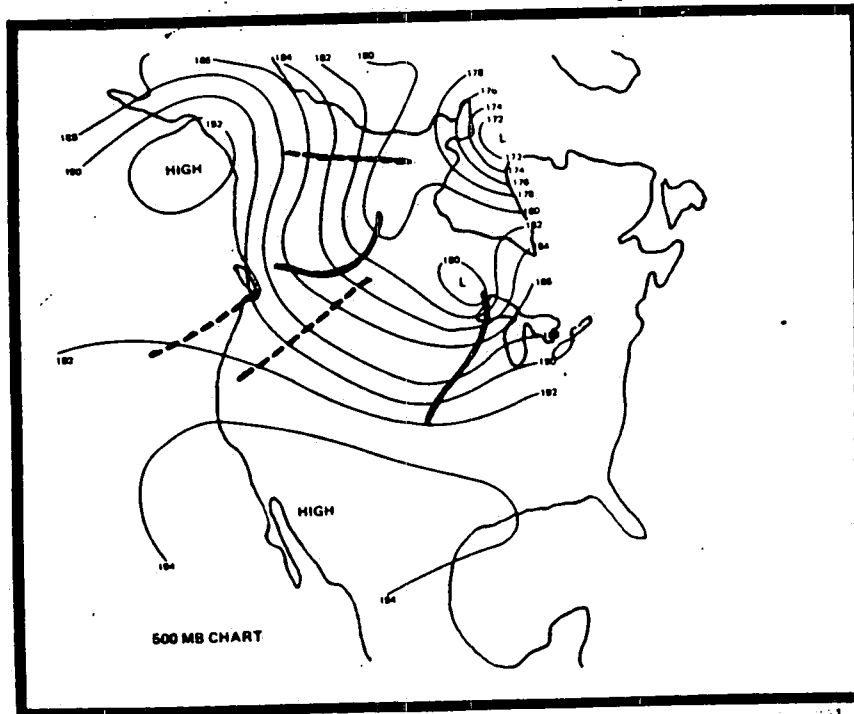
2. Short Wave Trough - The passage of short wave troughs in upper air flows, Map # 2 , often result in surface cold fronts that are accompanied by little rain. The extreme winds that sometimes accompany such cold fronts can often result in erratic extreme fire behavior.
3. Mid-western High - This system develops when a high aloft is associated with moist air masses at mid tropospheric levels, Map # 3 . Such high daytime heating may be extreme and orographic lifting of the moist air results in thunderstorms. As a result of the intense high moisture often never reaches the ground and dry strikes can occur in rapid succession.
4. Pacific High - This situation shown in Map # 4 often affects weather in Banff. As the moist maritime high passes over the mountain ranges to the west of Banff most of its precipitation is depleted. When it reaches the Rockies it is dry and under clear skies temperatures soar and humidities drop rapidly. The desiccating effects this type of system may have on the Rockies may lead to extreme fire danger. This system may have a particularly important influence on forest fuels in early spring.
5. Canadian Continental High - This pattern illustrated in Map # 5 is a common spring-fall system. As the dry Arctic air mass tracks south-southeast over the prairies it often warms at rapid rates. This type of situation can prove to be most severe if it remains quasi-stationary over the prairie provinces. Often strong, dry east winds bring hot, dry weather to southern Alberta. The greater the intensity of the system the more influence it has on Banff's weather.

Map # 1: Upper Ridge Synoptic Pattern



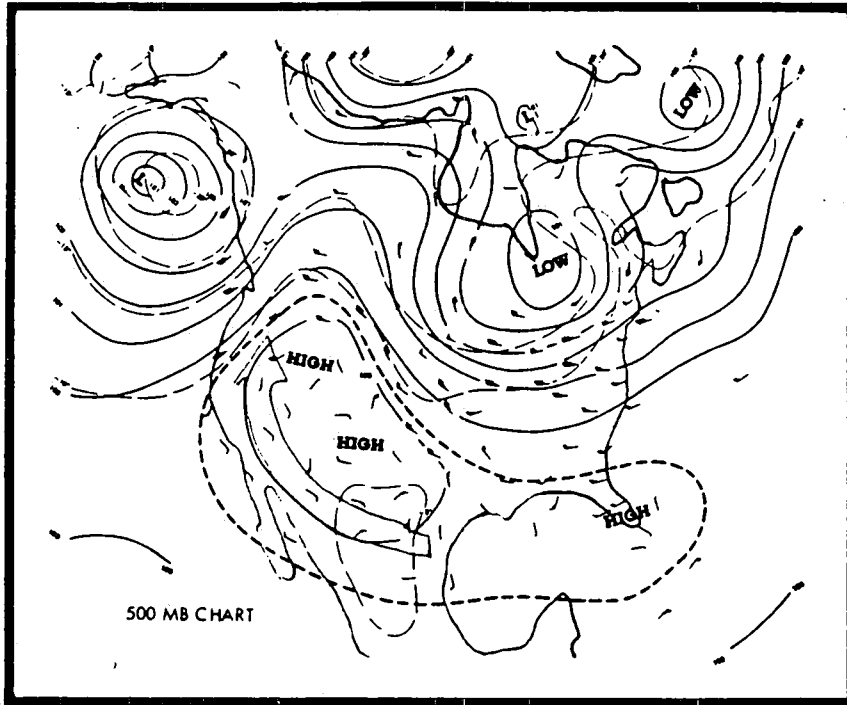
An upper air pattern associated with high fire danger during the summer in the Western United States has the subtropical High aloft located over the Far West. This pattern, illustrated by this 500-mb. chart, produces very high temperatures, low humidities, and unstable atmospheric conditions near the surface.

Map # 2: Short Wave Trough Synoptic Pattern



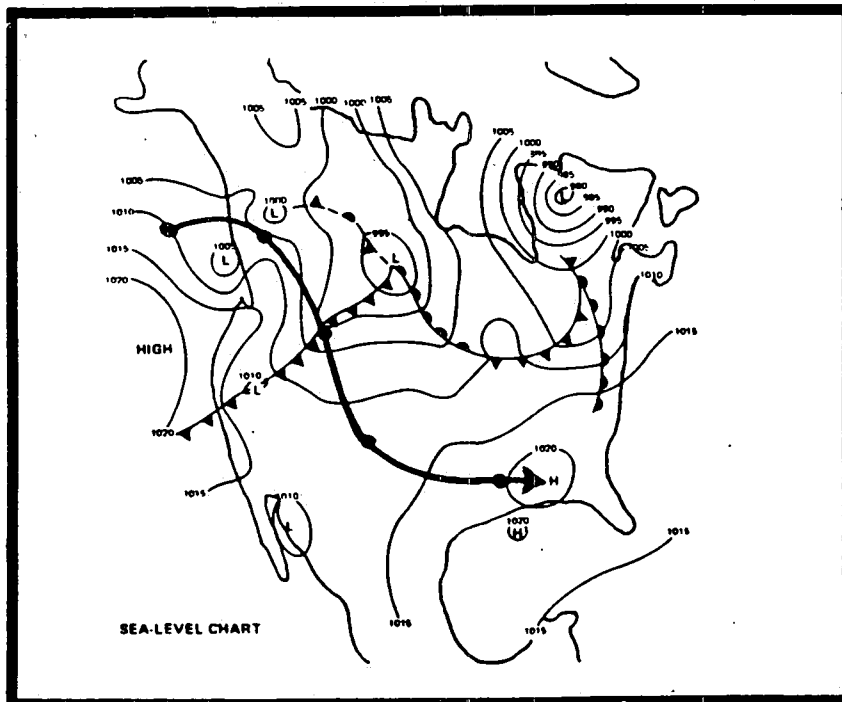
Short-wave troughs aloft, when accompanied by dry surface cold fronts, can cause high fire danger in the Great Basin and Rocky Mountain regions from late spring to early fall. This 500-mb. chart shows short-wave troughs moving eastward and southeastward in a northwesterly flow pattern. Past daily positions of the short-wave troughs are shown by heavy dashed lines.

Map # 3: Mid-western High Synoptic Pattern



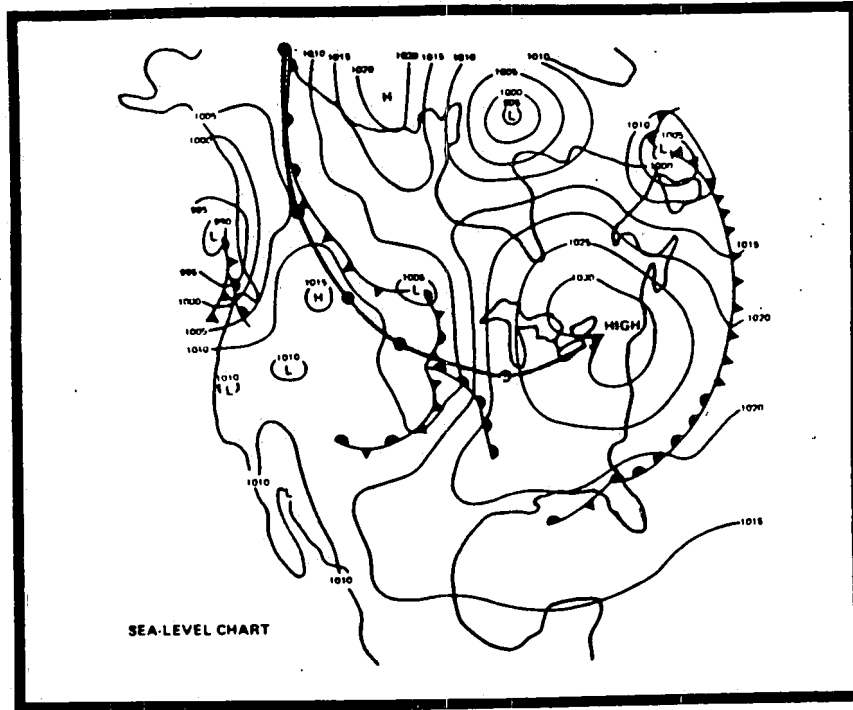
Moisture from the Gulf of Mexico is transported to the Southwest and the Western States at mid-tropospheric levels when a clear High aloft moves into the position shown on this 500-mb chart. Daytime heating and orographic lifting of the moist air combine to produce many high-level thunderstorms.

Map # 4: Pacific High Synoptic Pattern



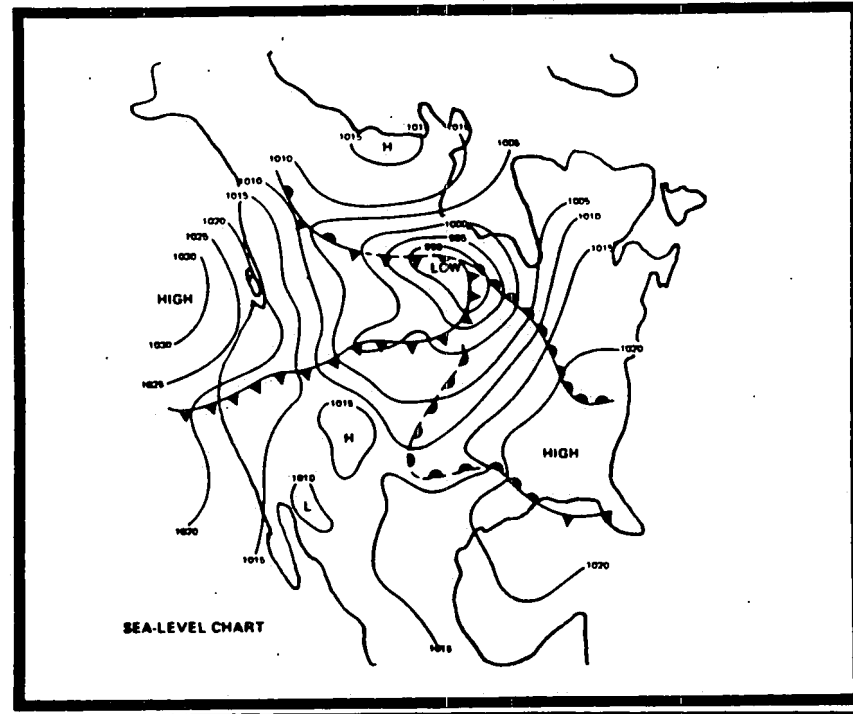
The Pacific High synoptic type is very common and can bring high fire danger to all regions east of the Rockies. An mP air mass enters the continent, usually in the Pacific Northwest or British Columbia, as a high-pressure area, loses much of its moisture as it moves across the mountains, and reaches the region east of the Rockies about as dry as cP air masses. The regions affected depend upon the track taken by the High. In this example, the low aloft was meridional and the High plunged southward along the Rockies and then moved eastward. In other cases, the low aloft may be zonal and the High will take a predominantly easterly course. Usually, the western or southwestern portion of the High is the most usual fire-danger area.

Map # 5: Canadian Continental High Synoptic Pattern



The Northwest Canadian High synoptic type is least frequent in summer and most frequent in winter. In winter the air mass is so cold, however, that fire danger is low. The highest fire danger is produced in spring and fall. As shown on this sea-level chart, a dry cP air mass from Northwest Canada moves southward under meridional flow aloft, and warms by subsidence and passage over warmer land as it moves to lower latitudes. It can affect all regions east of the Rockies. The north and northwest sides are most critical, but high fire danger can occur on any side of the High.

Map #6: Chinook Winds Synoptic Pattern



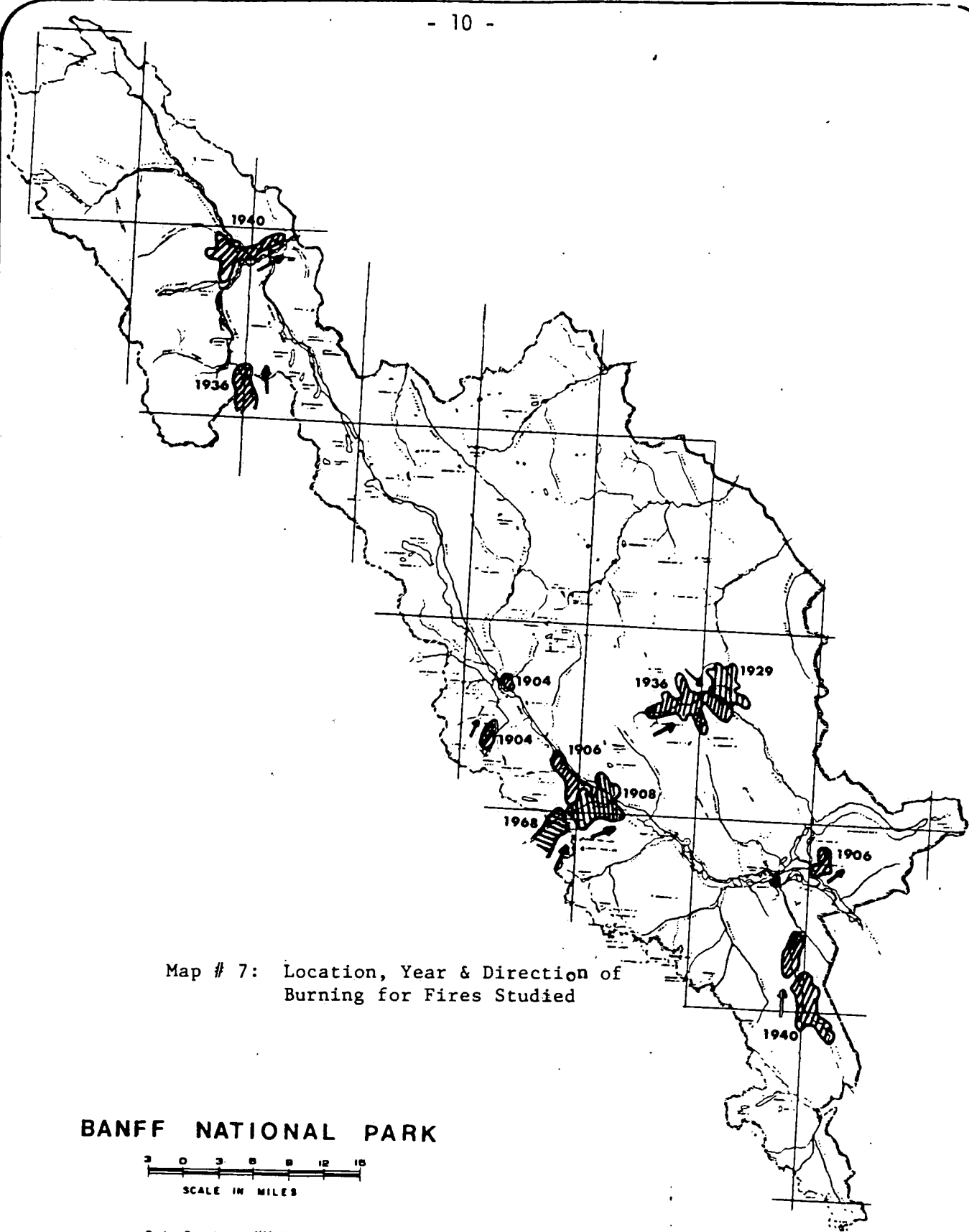
This winter sea-level chart illustrates the synoptic type producing chinook winds along the east slope of the Rockies. A High is located in the Great Basin and a front is in the Plains. In the area between the front and the Rockies, strong winds blow downslope, producing high temperatures and mostly low humidities. Airflow aloft is perpendicular to the mountain range. In this case, during 3 November days chinook winds progressed southward from Montana and Wyoming to Colorado, New Mexico, and Texas.

6. Chinook Winds - This type of situation is well known in the area just east of the Rockies. It is particularly dangerous in the spring in Banff. As a strong, westerly flow perpendicular to the mountain ranges occurs, descending air warms at the dry adiabatic lapse rate. Resulting winds are strong, hot and acutely dry and are capable of rapid desiccation of forest fuels. This pattern is particularly significant in montane regions of the park and can lead to extreme early season drying.(Map 6)..

METHODS

As Banff National Park moves into an era of fire management it is becoming increasingly important to attain a good understanding of the weather patterns which result in or promote wildfire occurrence. Seven fire seasons were chosen for indepth synoptic analysis. Fire seasons examined were chosen on the basis of fire frequency, fire size, seasonal burned area, fire behavior and available documentation. This report analyzes fire seasons for the following years: 1904, 1906, 1908, 1924, 1936, 1940 and 1968. Map # 7 illustrates the date, location and direction of burn of the fires scrutinized.





As is often the case with post-factum analysis, a great deal of valuable data is either no longer available or was never recorded. This became particularly evident as analysis of pre-1940 seasons was initiated. In 1904 there was a scant four weather stations in Alberta. These were: Medicine Hat, Fort Calgary, Edmonton and Fort Smith. The resulting surface maps drawn for Alberta are based solely on these four widespread stations; the shortcomings are obvious. As time passed atmospheric recording stations increased and measurement techniques improved and by the mid-forties upper air observations were being conducted. Unfortunately, only one major fire occurred after 1940. Pre-1968 weather maps are also plagued by changes in weather station data recording. This factor compounded problems of analysis.



Map # 7: Location, Year & Direction of Burning for Fires Studied

BANFF NATIONAL PARK

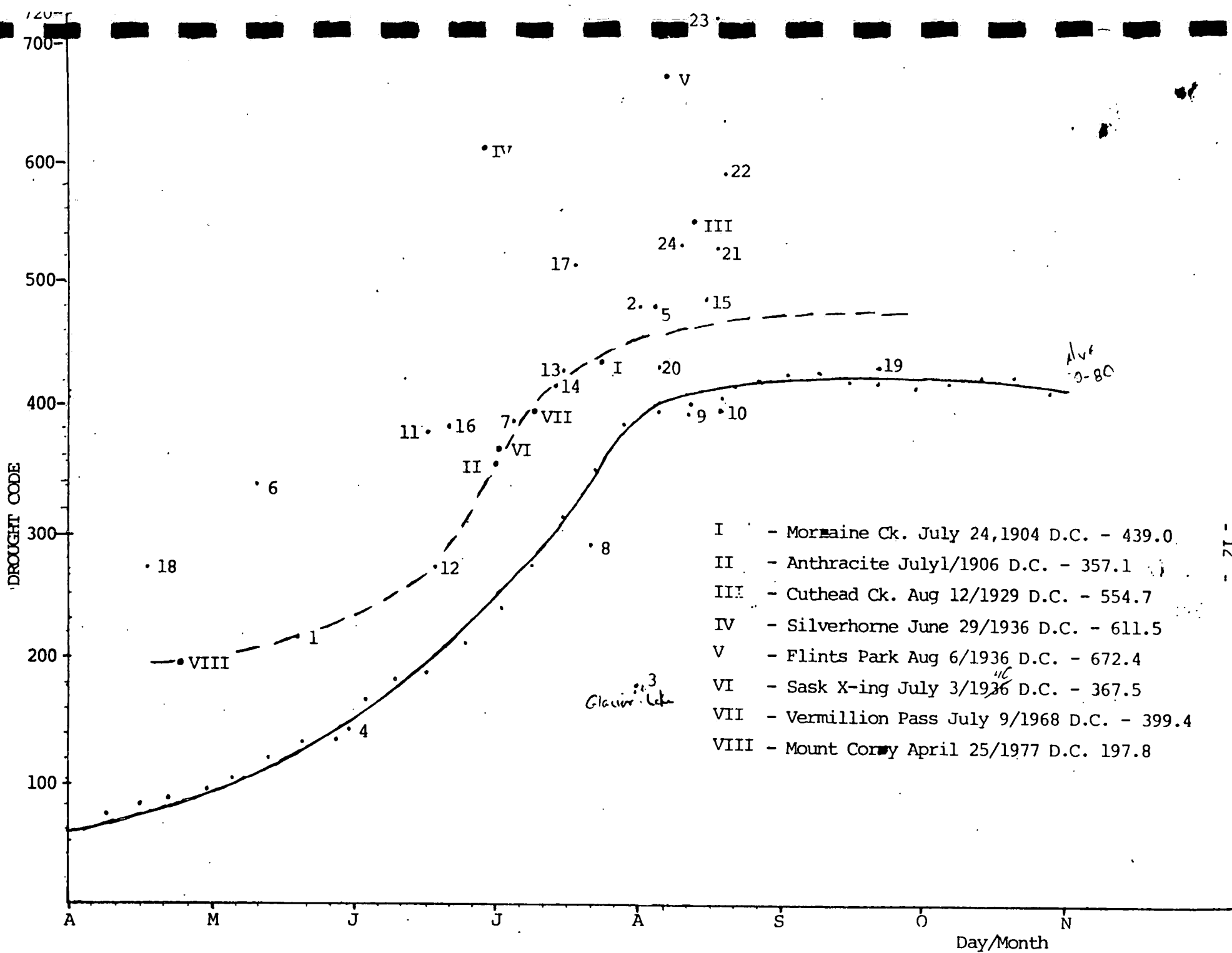


- Park Boundary 
- Main Highway 
- Secondary Road 
- Trails 

Banff has been fortunate to have had an elementary weather station since 1890. Temperatures and rainfall have been recorded since that time. This information was used in conjunction with historic weather maps obtained from the Atmospheric Environment Service in Downsview, Ontario to analyze fire season severity and tendencies. This data, along with historic fire documentation forms the basis of this report. Seasonal Park Warden John Kellas produced a modified version of the Northern Forest Research Centre's Fire Weather Index Program and Banff weather data to produce drought code values back to 1890. This information was particularly useful in correlating drought and fuel moisture trends to fire occurrence and was extremely useful in following fire season development and severity.

Once a complete historic drought code data base existed, a mean season was determined by averaging daily drought code values for 1970-1980. A graphic representation of average daily drought codes may be seen in graph # 1. Ignition day drought codes were plotted on this graph for every fire that reached 40 ha. in size from 1890 to the present. An arbitrary value of 80% was used to define a threshold drought code curve. Eighty per cent of all fires at least 40 ha. in size have had ignition day drought codes in excess of the threshold line.

Park Warden John Kellas began the preliminary synoptic analysis in the summer of 1982. This preliminary analysis has been expanded to this draft report. Surface maps were scrutinized and synoptic patterns were correlated to temperature and rainfall trends in Banff. Review of surface maps was carried out at the Archives of the Canadian Rockies. Synoptic patterns of importance to the fire season in question were drawn on base maps and data conversions were made to provide consistency of station information. Additional information regarding monthly temperature and precipitation averages and extremes was obtained from the Atmospheric Environment Service in Banff. The Atmospheric Environment Service in Edmonton provided assistance in obtaining historic monthly weather reviews for both the United States and Canada. These historic maps and documents provided useful information in analyzing province-wide analysis of weather patterns and greatly



Graph #1 Average D.C. & Threshold D.C.

assisted in ascertaining widespread synoptic trends. Whenever available, measurements of upper air levels were incorporated into the analysis in order to gain a greater understanding of synoptic development and surface influences. All this data was then scrutinized repeatedly in order to uncover synoptic trends and fire influences. The compilation of all this information was then drafted into fire season analyses and summaries.

Each season description is composed of four parts. The first part, general description, outlines the fire or fires of importance during the season and describes burn dates, ignition sources, final fire size and additional information incorporated into the season analysis. The second part of the season analysis is entitled "Synoptic Situation in Month Preceding Fire". This section examines winter and spring precipitation and relates it to fire season occurrence. It also incorporates monthly temperature and precipitation trends and examines drought code development throughout the spring and summer months prior to the fire. Synoptic patterns which result in high temperatures and significant rainstorms are scrutinized in detail. Surface and upper air maps when available are included to illustrate unusual synoptic phenomena. The third section, "Synoptic Situation Immediately Preceding and During the Fire", is often the most lengthy part of the season analysis. This section deals with the synoptic patterns which lead up to the ignition of the fire and behavior of the fire. Day-to-day analysis is often essential to fully understand fire behavior. The final section of the season analysis is entitled, "Synoptic Situation at the End of the Fire". This section is usually short and concise and describes synoptic development which brings rain and cool temperatures and an end to the fire.

The conclusion and discussion of this paper is founded upon a synoptic summary table. This table was developed to compare fire weather variables for all the fires in question. In this way recurring trends may be identified and the major factors bringing up a bad fire season may be outlined. These factors can then be used as a check list for examining future fire seasons in order to determine their severity and plan for either suppression or prescribed burning.

MORaine LAKE FIRE - JULY 24-31, 1904

LAKE LOUISE FIRE - AUGUST 3-8, 1904

GENERAL DESCRIPTION

During the spring and summer of 1904 approximately 2,200 ha. of Banff National Park burned in three separate fires. The synoptic situations which influenced the occurrence of these fires will be discussed in this analysis. The Alexandra River Fire, although being the largest of the three was never documented and will, therefore, not be discussed in this analysis. The second largest fire was the Moraine Lake Fire which burned from July 24-31 consuming approximately 500 ha. The third major fire of 1904 was the Lake Louise fire which burned from August 3-8 consuming 200 ha.

This analysis, being for the earliest fire season, is based on the least amount of information. Synoptic maps were developed using fewer station observations and is, therefore, the most debatable. This, however, is not to say that this year's analysis is the least valuable but it is the least profound.

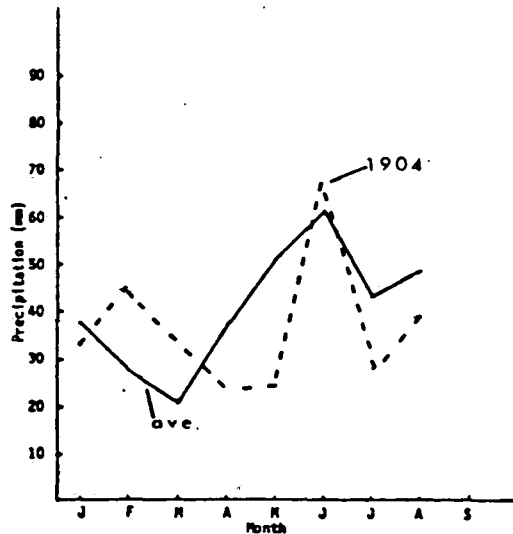
SYNOPTIC SITUATION IN MONTHS PRECEDING THE FIRE

The Banff winter of 1903/04 was not particularly dry with December, 1903 and January-February 1904 receiving 90% of the normal precipitation. Table #1, Banff Precipitation, Page 15 illustrates these trends and reveals that spring precipitation was also not excessively dry and Banff received 92% of the normal precipitation. It is important to note that of the six month span only two months had total precipitation values above their norms. February and March precipitation values were well above normal which compensated for below normal precipitation in December and January and had definite cushioning effects on ground and fuel moisture in the early spring. The start up drought code had a value of 66.8, which is just barely above normal by 11.5 points. In other words, as the fire season began

TABLE #1 - Banff Monthly Precipitation - 1904

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
1904	3.33	4.39	3.43	2.44	2.46	6.68	2.21	3.78	28.72
Ave.	3.82	2.78	2.09	3.76	5.18	6.13	4.24	4.89	32.18
% of Norm	87.0	157.9	164.0	64.9	47.5	110.0	52.1	77.3	89

Graph #2 - Precipitation Trends - 1904



Graph #2 - Precipitation Trends - 1904

Table 2:

BANFF NATIONAL PARK DROUGHT CODE VALUES

CARRY-OVER VALUE: 0-Jc

Station is Banff; Overwinter Mean = 179mm
Year = 1904

Date	Temp.	Rain	D.C.
4 1	6.4	0.0	2.8
4 2	8.7	0.0	5.3
4 3	5.9	0.0	7.4
4 4	3.7	0.8	9.0
4 5	0.3	1.5	10.0
4 6	1.4	9.9	1.2
4 7	-0.2	0.0	2.1
4 8	4.2	0.0	3.8
4 9	7.6	0.0	6.2
4 10	9.8	0.0	8.9
4 11	11.4	0.0	11.9

Remarks

overwinter precip. = 156.5

Spring Start-up Value = 66.8 Approximately average start-up index

4 12	15.3	0.0	70.5
4 13	16.4	0.0	74.4
4 14	14.2	0.0	77.9
4 15	1.4	0.0	79.1
4 16	5.3	0.0	81.0
4 17	8.7	0.0	83.5
4 18	10.3	0.0	86.3
4 19	10.9	0.0	89.3
4 20	10.9	0.0	92.2
4 21	10.3	0.8	95.0
4 22	7.6	0.0	97.3
4 23	7.0	2.3	99.5
4 24	9.2	0.0	102.1
4 25	13.7	0.0	105.6
4 26	15.9	0.0	109.4
4 27	18.1	0.0	113.6
4 28	14.8	3.0	114.0
4 29	8.7	0.5	116.5
4 30	3.1	5.6	109.2
5 1	3.7	1.0	112.3
5 2	8.7	2.0	116.3
5 3	12.6	0.0	121.0
5 4	9.8	1.3	125.1
5 5	4.8	0.0	128.4
5 6	5.9	0.0	131.9
5 7	4.8	0.5	135.1
5 8	7.6	0.0	138.9
5 9	9.8	0.0	143.1
5 10	8.7	0.0	147.0
5 11	6.4	0.5	150.6
5 12	12.0	0.0	155.2
5 13	15.9	0.0	160.4
5 14	13.7	0.0	165.3
5 15	9.8	1.0	169.5
5 16	13.1	0.0	174.2
5 17	13.7	0.0	179.1
5 18	14.8	2.0	184.2
5 19	11.4	10.2	166.8
5 20	17.0	0.0	172.2
5 21	16.4	0.0	177.6
5 22	12.0	1.8	182.2
5 23	8.7	1.0	186.1
5 24	3.7	1.8	189.2
5 25	10.3	0.0	193.5
5 26	14.8	0.0	198.5

Influx of warm air + southerly winds

Numerous troughs throughout May, most lows track south of Banff, resulting in low precipitation.

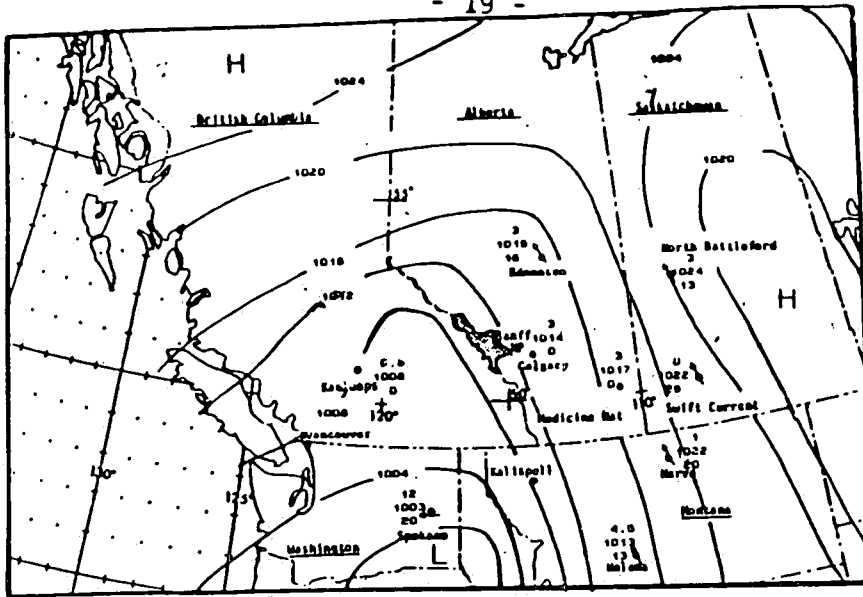
Low pressure system tracks over Banff.

Date	Temp.	Rain	D.C.	Remarks
5 27	13.7	0.0	203.4	
5 28	9.8	0.5	207.6	
5 29	14.2	0.0	212.5	
5 30	14.8	0.0	217.6	
5 31	12.0	1.0	222.2	
6 1	9.8	2.8	227.3	
6 2	5.3	5.8	219.6	
6 3	12.0	0.5	225.1	
6 4	18.7	0.0	231.9	
6 5	18.7	2.8	238.7	
6 6	9.2	6.4	229.5	
6 7	7.0	1.5	234.2	
6 8	12.6	0.0	239.9	
6 9	14.8	1.5	245.9	
6 10	6.4	2.1	198.0	Low pressure, upslope winds
6 11	11.4	0.3	203.4	
6 12	14.8	0.0	209.5	
6 13	16.4	0.0	215.9	
6 14	19.2	0.0	222.7	
6 15	21.4	0.0	230.0	
6 16	20.9	0.0	237.1	
6 17	20.3	0.0	244.2	
6 18	12.6	2.6	192.2	Low pressure, upslope winds
6 19	12.0	1.3	202.7	
6 20	14.3	0.0	208.8	
6 21	14.3	0.3	214.9	
6 22	7.6	2.5	219.6	
6 23	8.1	0.3	224.5	
6 24	14.2	0.0	230.5	
6 25	17.0	0.0	236.9	
6 26	16.4	0.5	243.3	
6 27	14.8	0.0	249.3	
6 28	20.3	0.0	256.4	
6 29	23.7	0.0	264.1	
6 30	26.4	0.0	272.2	High pressure over Sask. - brisk southerly winds
7 1	24.2	0.0	280.3	
7 2	25.3	0.0	288.5	
7 3	22.0	0.0	296.2	
7 4	23.7	0.0	304.2	
7 5	26.4	0.0	312.6	
7 6	26.4	0.0	321.1	
7 7	22.6	0.3	328.9	Well defined low centred over southern Alberta
7 8	13.1	2.5	335.8	
7 9	23.7	0.0	343.3	
7 10	25.3	0.0	352.1	
7 11	26.4	0.0	360.5	
7 12	22.6	5.1	354.2	
7 13	16.4	0.0	360.8	
7 14	17.0	0.0	367.6	
7 15	15.3	0.8	374.0	
7 16	11.4	1.3	379.3	
7 17	12.6	0.5	385.8	
7 18	13.7	0.0	391.9	
7 19	18.7	0.0	399.0	Barometric pressure rises - high pressure over park.
7 20	24.2	0.0	407.1	
7 21	28.1	0.0	415.8	
7 22	28.1	0.3	424.6	
7 23	22.6	0.0	432.4	
7 24	16.4	0.0	439.0	Moraine Lake fire begins
7 25	22.0	0.0	446.7	coastal high moves in
7 26	25.9	0.0	455.1	probable erratic fire behavior - low pressure system
7 27	26.4	0.0	463.5	fire ends.
7 28	23.1	2.5	471.4	
7 29	13.7	7.2	445.1	
7 30	15.9	0.5	451.6	
7 31	20.9	0.0	459.1	
8 1	23.1	0.0	466.3	
8 2	22.6	0.0	473.3	
8 3	24.2	0.0	480.7	
8 4	24.2	0.0	488.2	Strong high pressure dominating Alberta weather
8 5	22.6	0.0	495.2	Lake Louise fire begins
8 6	20.9	0.0	502.0	low over B.C. tracks east
8 7	18.1	9.7	464.0	fire ends
8 8	20.3	0.0	470.6	
8 9	23.1	0.0	477.3	
8 10	20.9	0.0	484.6	

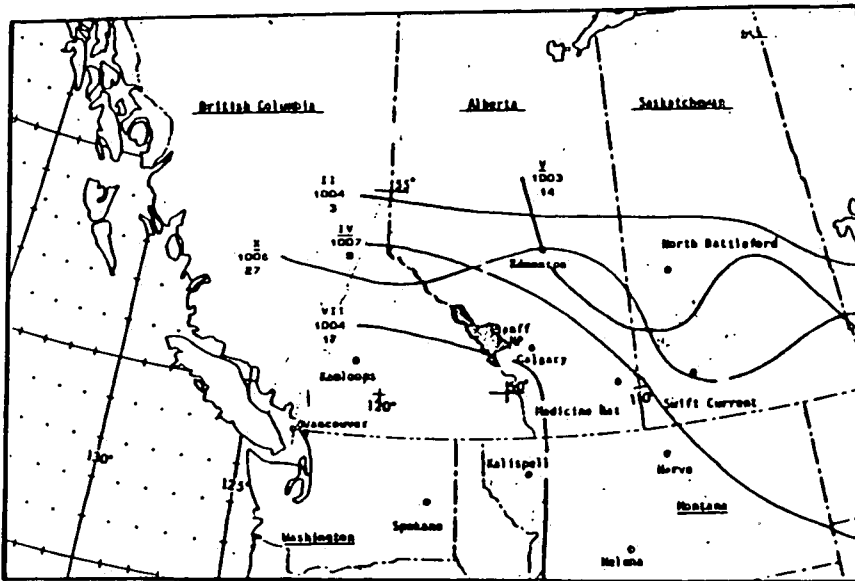
Date	Temp.	Rain	DC
8 11	13.1	0.0	490.8
8 12	20.2	0.0	497.2
8 13	24.2	0.0	505.0
8 14	24.8	0.0	512.4
8 15	23.1	0.0	518.6
8 16	19.2	0.0	526.1
8 17	20.3	0.0	532.8
8 18	18.7	0.0	539.2
8 19	12.6	16.5	459.4
8 20	9.8	5.1	446.7
8 21	12.6	0.0	451.9
8 22	14.8	0.0	457.6
8 23	10.3	0.0	462.5
8 24	15.9	0.0	468.3
8 25	21.4	0.0	475.2
8 26	20.3	0.0	481.8
8 27	18.1	0.0	488.1
8 28	14.8	0.0	493.8
1			
8 29	15.9	2.8	499.6
8 30	15.3	0.0	505.4
8 31	9.8	1.8	510.2
9 1	17.0	0.3	514.9
9 2	18.7	0.0	520.0
9 3	17.0	0.0	524.8
9 4	16.4	0.0	529.4
9 5	20.9	0.0	534.9
9 6	21.4	0.0	540.4
9 7	20.3	0.0	545.8
9 8	20.3	0.3	551.2
9 9	12.0	3.8	540.6
9 10	10.9	0.0	544.2
9 11	10.9	0.0	547.9
9 12	10.3	0.0	551.5
9 13	15.9	0.0	556.0
9 14	18.1	0.0	561.0
9 15	16.4	0.0	565.7
9 16	14.2	1.8	569.9
9 17	8.1	0.0	573.1
9 18	4.2	7.4	537.2
9 19	7.6	0.0	540.3
9 20	12.6	0.0	544.3
9 21	15.9	0.0	548.9
9 22	10.9	0.0	552.5
9 23	3.7	2.5	554.9
9 24	12.6	0.0	558.9
9 25	13.7	0.0	563.0
9 26	16.4	0.0	567.7
9 27	12.6	0.0	571.7
9 28	10.9	1.0	575.3
9 29	11.4	1.0	579.1
9 30	17.6	0.0	584.0

Remarks

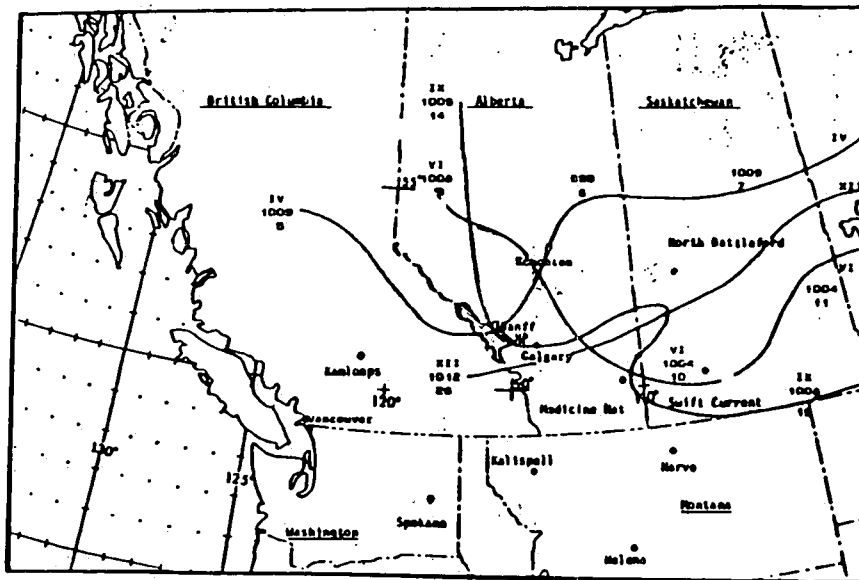
Rainfall eliminates fire danger for remainder of season.



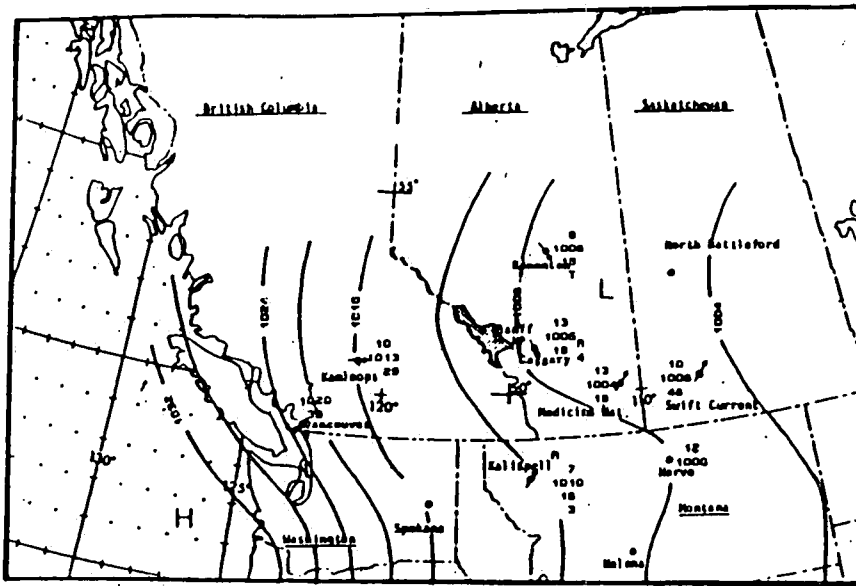
Map #8: Surface Map:
April 26, 1904 - 8:00 a.



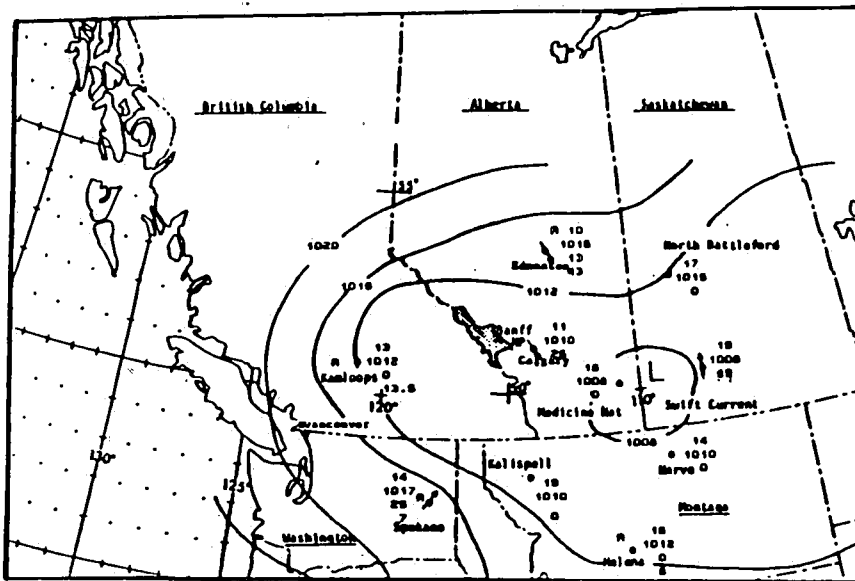
Map # 9: Surface Map:
May Low Pressure System
tracks



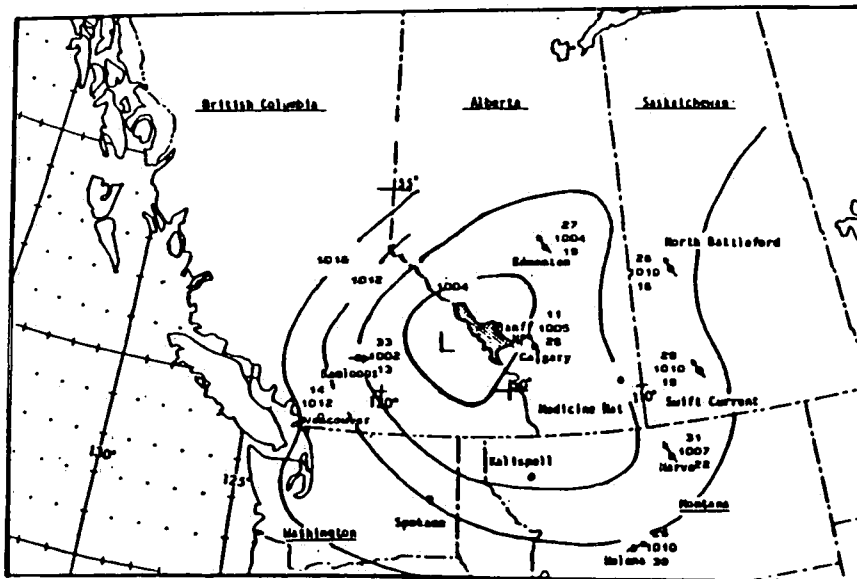
Map # 10: Surface Map:
June Low Pressure System
tracks



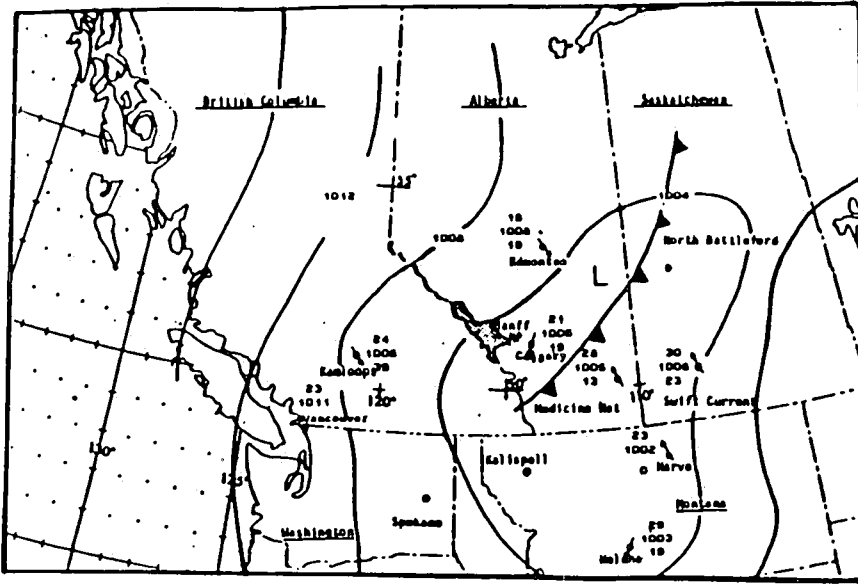
Map # 11: Surface Map:
June 10, 1904 - 8:00 p.m.



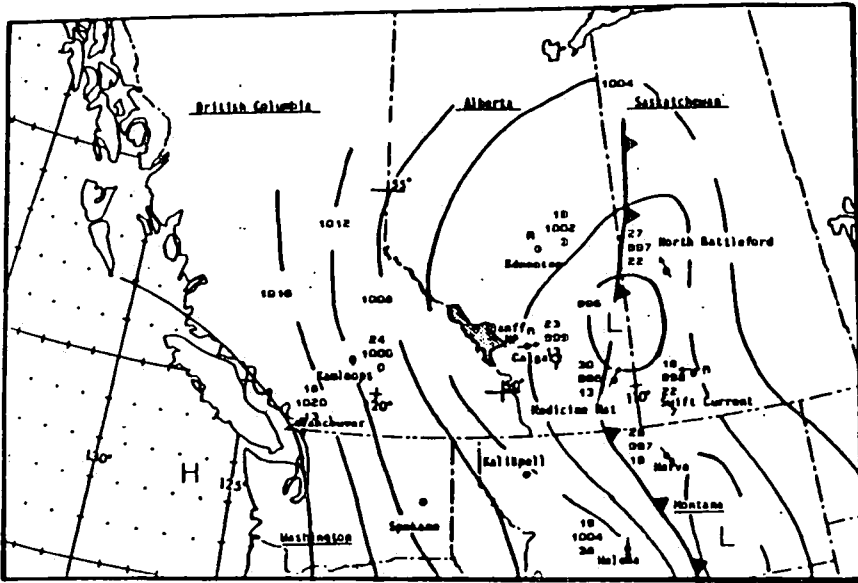
Map # 12: Surface Map:
June 18, 1904 - 8:00 p.m.



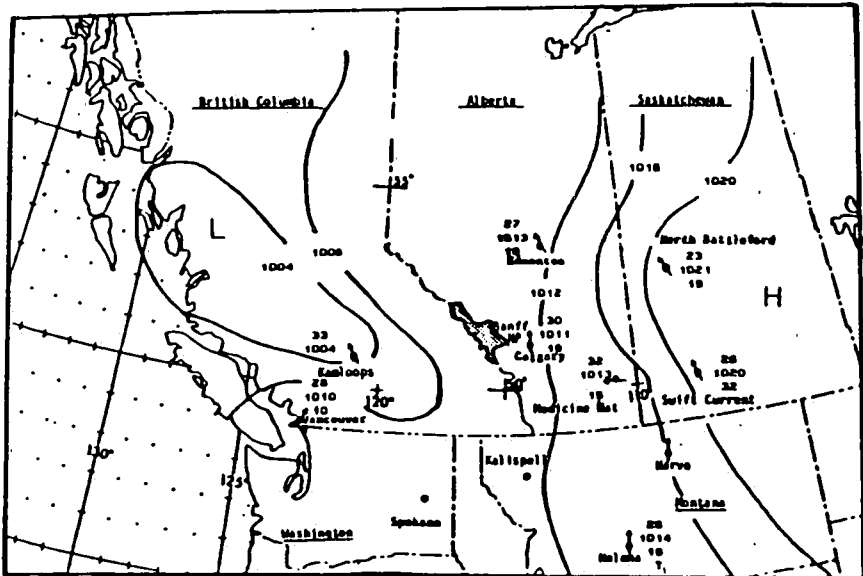
Map # 13: Surface Map:
June 30, 1904 - 8:00 p.m.



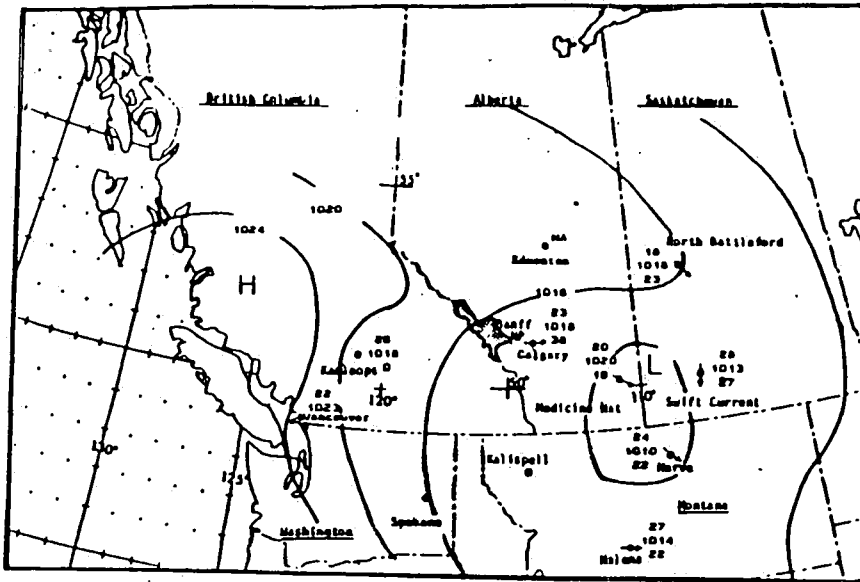
Map # 14: Surface Map:
July 7, 1904 - 8:00 p.m.



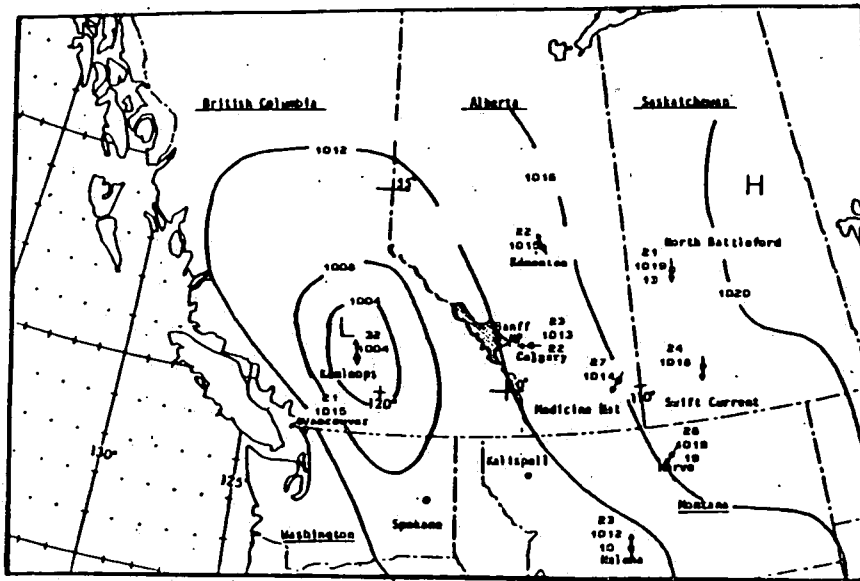
Map # 15: Surface Map:
July 12, 1904 - 8:00 p.m.



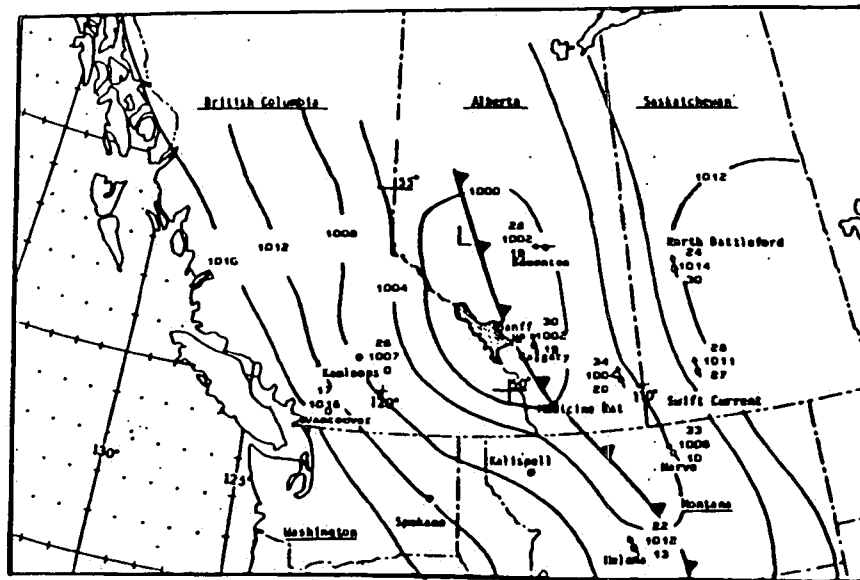
Map # 16: Surface Map:
July 21, 1904 - 8:00 p.m.



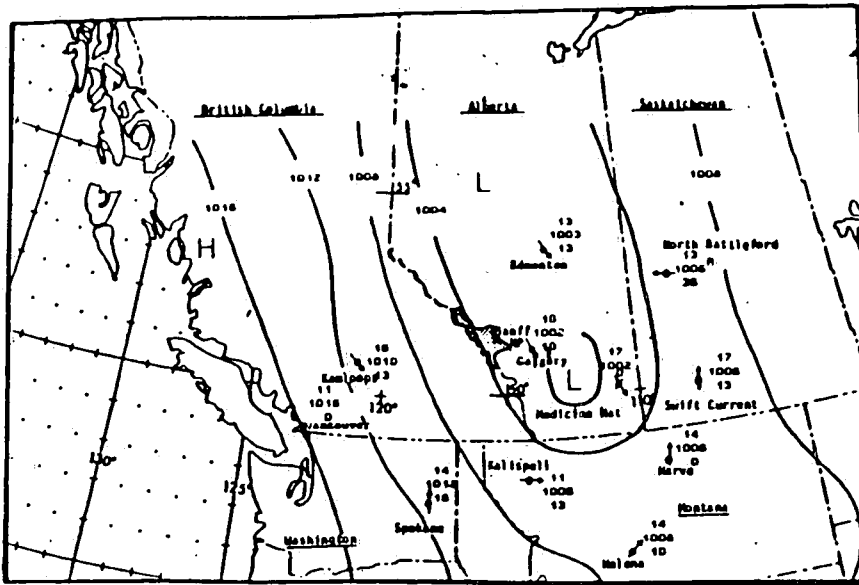
Map # 17: Surface Map:
July 21, 1904 - 8:00 p.m.



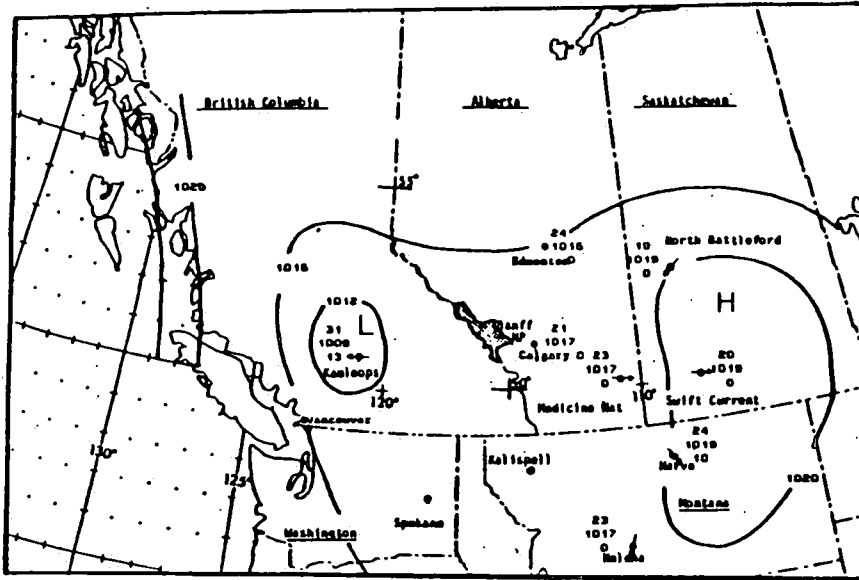
Map # 18: Surface Map:
July 26, 1904 - 8:00 p.m.



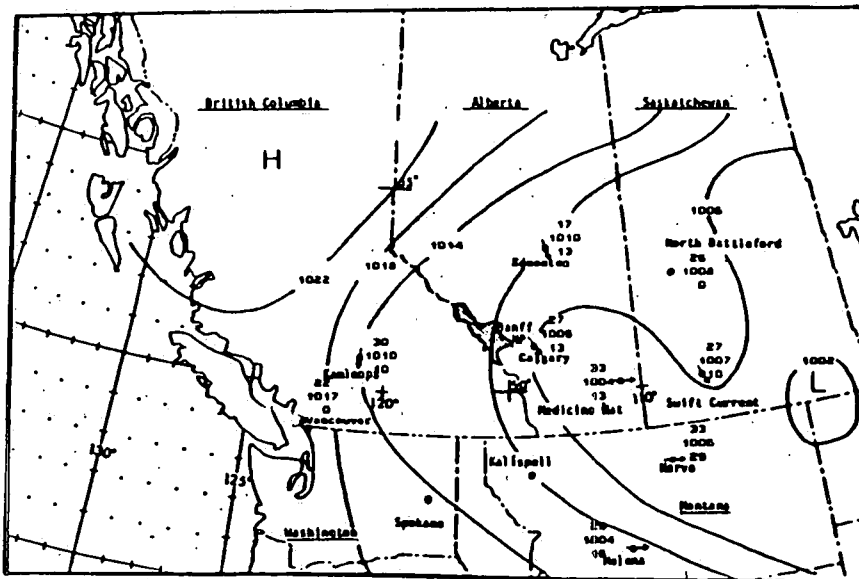
Map # 19: Surface Map:
July 27, 1904 - 8:00 p.m.



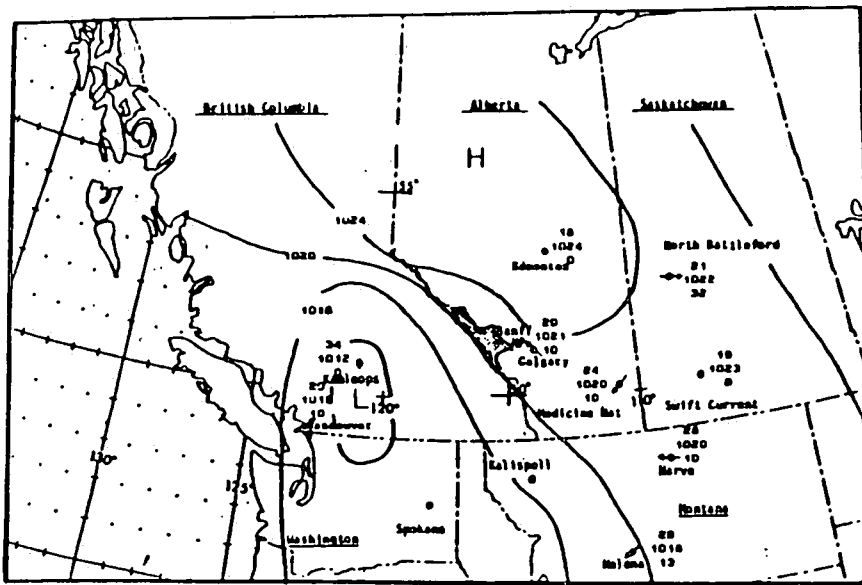
Map # 20: Surface Map:
July 28, 1904 - 8:00 p.m.



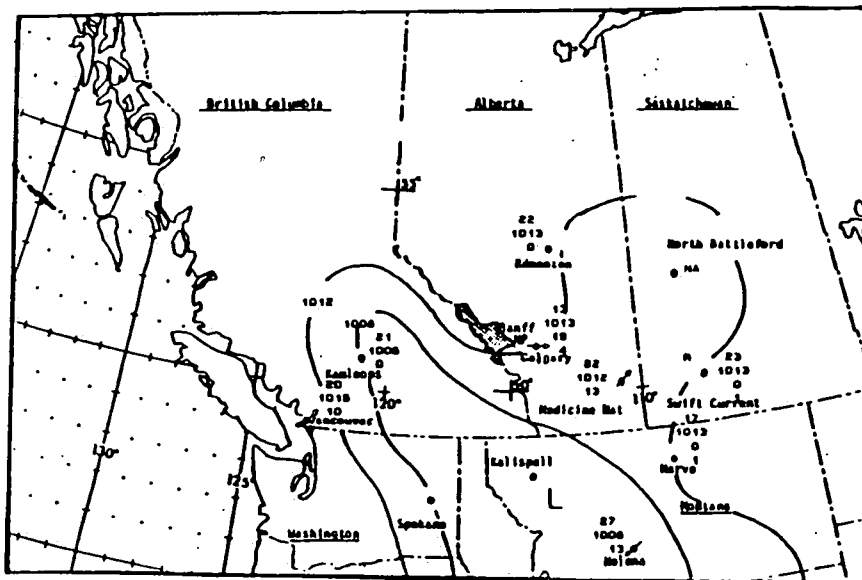
Map # 21: Surface Map:
July 31, 1904 - 8:00 p.m.



Map # 22: Surface Map:
August 2, 1904 - 8:00 p.m.



Map # 23: Surface Map:
August 5, 1904 - 8:00 p.m.



Map # 24: Surface Map:
August 7, 1904 - 8:00 p.m.

no moisture deficit was occurring. However, with the passage of April and May and the materialization of monthly precipitation values of 64.9 and 47.5% respectively of the norm, drought codes began to rise.

Throughout April and May a rapid succession of ridges and troughs passing over Banff resulted in large fluctuations in daily temperatures, Map # 8 , April 26, 1904, exemplifies a situation which resulted in an influx of warm air from the central midwestern States and brought temperatures 10°C above the normal daily maximum on the 27th. Gradient flow around such a system promotes dry southerly winds and warm temperatures which desiccate fine fuels at rapid rates. This situation can greatly increase the probability of rapidly spreading - moderate intensity fires in montane regions. If sustained for long periods of time, one to two weeks, such synoptic situations spawn extremely severe fire conditions.

May appeared to be a month in which the weather was dominated by the passage of troughs. Five to be exact. Map # 9 , May Low Track, indicated the paths followed by these lows and reveals that most of these low pressure systems followed tracks several hundred miles north of Banff. This may be responsible for significantly low precipitation and unusually low temperatures. Temperatures in Banff exceeded the average daily high on only five days. The low pressure system which brought the most precipitation to Banff is shown as number VII and is the only system which tracked over Banff bringing 50% of the month's precipitation. With the conclusion of an unusually dry May drought codes were now 120 points above normal and the likelihood of a bad fire season was becoming imminent. Graph # 2 , page 15 , 1904 Precipitation Trends depicts this tendency distinctly.

June was also a relatively cool month with only nine days when temperatures exceeded the June daily high temperature of 18.1°C . Map # 10 , Track of June Lows, depicts four low pressure systems tracking near Banff. Two of these systems, lows VI and IX, resulted in rainfall in excess of 20 mm/24 hr each. Maps #11 , June 10, 1904

and # 12, June 18, 1904 reveal that on both occasions, intensive low pressure systems over Alberta produced upslope winds and significant precipitation in Banff. This precipitation which resulted from the two systems constituted 61% of June's precipitation which was 110% of the normal. If these two systems had not brought this badly needed precipitation the 1904 fire season would have undoubtedly been much worse.

As June came to a close temperatures rose above normal as a high pressure system over Saskatchewan and a low pressure system over Oregon promoted south winds into Alberta. Map # 13, page , depicts the surface situation which on the 30th raised temperatures to 26°C.

SYNOPTIC SITUATION IMMEDIATELY PRECEDING AND DURING THE MORAINE LAKE FIRE

Throughout the first week of July temperatures exceeded the average daily maximum every day. This, in conjunction with the complete lack of precipitation, resulted in drought codes rising by 6-9 points each day. This drying helped to raise the drought code to 329 on the 7th which was 49 points above normal indicating that a slight moisture deficiency was occurring. Temperatures moderated on the 7th and 8th (see Map # 14) as a trough extending into Alberta developed into a well defined low centered over southern Alberta. As this low tracked northeast on the 8th, 205 mm. of rain fell in Banff. This storm, not bringing significant precipitation, had little effect on the drought code. By the 10th this low was quasi-stationary over the Northwest Territories and a tongue of low pressure extended back into Alberta. As of the 12th Map # 15 , the trough had developed into a well defined low centered over southern Alberta and Montana. Associated with this low were upslope winds in the Rockies and 5.1 mm. of rain fell in Banff. Remnants of this low pressure system remained quasi-stationary over Alberta, slowly deepening until the 15th when it began to track east-northeast as a high pressure system pushed inland over the Oregon coast. On July 17, again a tongue of low pressure extended back into western North America from the previous low now situated over the Northwest Territories. This developed into a small low pressure cell in the evening and winds were northwest at 12 as .5 mm.

of rain fell in Banff. Since the development of the original low on July 4, and resulting from its subsequent subsidiary lows, western Canada's weather until July 18 had been quite variable and 11 mm. of rain had fallen in Banff.

Barometric pressure began to rise on the 18th as a high moved inland over the British Columbia-Washington coast. By the 20th this high had tracked northeast as a low moved inland over the Washington coast. As high pressure over Alberta dominated the weather clear skies, high temperatures and southeast winds dried fine fuels quickly. Map # 16 , July 21, 1904 depicts the synoptic situation that brought this hot dry weather to Banff. By the 22nd the coastal trough of the previous day laid over Alberta, winds continued from the south and temperatures in Banff remained in the high twenties. The trough continued to track east and as winds switched to the northeast on the 23rd temperatures moderated.

On July 24th the Moraine Lake Fire began with the ignition source believed to be campers. The drought code in Banff was 439 which was 69 points above normal owing to an overall lack of precipitation. Map # 17 , July 24, 1904 depicts the surface weather situation and reveals that a high pressure system had pushed inland over the British Columbia coast. Temperatures on the 24th were cool as the gradient flow was from the west-northwest. As the coastal high moved inland on the 25th temperatures climbed and winds were from the west. The fire appeared to have started on the north shore of Moraine Lake and had burned out of control in an east-northeast direction. Information regarding fire behavior is scarce, however, it appears that rate of spread would not have been extreme and that no fire runs occurred during these first days. Drought code values were not extreme and temperatures remained below 23⁰C on both days.

The high pressure system of the 25th tracked east (see Map 18 .) and by the evening of the 26th was over Manitoba and Saskatchewan. A low pressure system laid over British Columbia. As this synoptic situation occurred winds shifted from the west to the south-southeast

and temperatures rose to 26°C. The low pressure system tracked east-northeast on the 27th, and its associated cold front passed over the Moraine Lake area in the late afternoon probably brought erratic fire behavior and increased rates of spread and intensity followed by a subsequent lull in fire activity. Map # 19, July 27 depicted the passage of the low pressure system and its location as of 8 p.m. The low remained quasi-stationary over Alberta throughout the evening and into the morning of the 28th.

SYNOPTIC SITUATION AT THE END OF MORAINÉ LAKE FIRE

Throughout the night of the 27th and into the morning of the 28th (see Map # 19) the low pressure system of the previous day tracked east-northeast over Alberta. Gradient flow was from the north on the 28th and temperatures fell along with 2.5 mm. of rain. The rain, windshifts and falling temperatures brought the fire under control and it was unlikely that any further spread occurred throughout the 28th. On the 28th (Map # 20) as a high pressure system off the Oregon coast pushed inland, and the previous day's low tracked northeast, winds continued from the north-northwest and in conjunction with low temperatures, 13.7°C came 7.9 mm. of rain. This rain assured the cessation of the Moraine Lake Fire which had burned 500 ha. over the past five days. Another .5 mm. of rain fell on the 30th of July bringing July's total precipitation to 52.1% of the normal.

SYNOPTIC SITUATION IMMEDIATELY PRECEDING THE LAKE LOUISE FIRE

On July 31 (Map # 21.) a high pressure system laid over the western Canadian-U.S. border; its movement into western Canada forced the low pressure system of the 28th and 29th over Hudson's Bay. Temperatures rose as clear, dry weather prevailed. July had been a warm month with 19 days when the high temperature exceeded the average daily high. This in conjunction with low precipitation had maintained a moisture deficit in deep duff layers. Although the precipitation of the 28th

and 29th moderated the drought code it was 74 points above normal on August 1.

The weak high of the 31st rapidly tracked southeast on August 1 as a trough extended into British Columbia from the Yukon and Alaska. By August 2nd, Map #22, this trough had become a well developed low over the prairies and north central States and a high pressure system was situated over northern British Columbia. Barometric pressure rose on the 3rd as the previous day's high began influencing Alberta's weather. Temperatures were 24°C under clear skies and winds shifted from the west in the morning to southeast in the evening as the high tracked southeast. Barometric pressure increased as Alberta's weather was dominated by a strong high pressure system on the 4th and 5th.

The Lake Louise Fire began on August 5th with ignition being attributed to the railway. The drought code was 90 points above the normal of 405. Map #23, August 5th, illustrates the surface situation on the first day of the Lake Louise Fire. Gradient flow suggests southeast winds as the high pressure system tracked southeast over Alberta and a low developed in British Columbia. The Lake Louise Fire was kept under control by fire crews as the synoptic situation of the 5th remained stationary but temperatures decreased as the low in British Columbia began to affect local weather.

SYNOPTIC SITUATION AT THE END OF THE LAKE LOUISE FIRE

Throughout August 7th the low which had been over British Columbia for two days intensified and tracked east (see Map #24). Temperatures fell to 18.1°C and 9.7 mm. of rain was recorded in Banff. This rain brought an end to the Lake Louise Fire which attained a size of 200 ha.

CASTLE JUNCTION FIRE - JULY 4-12, 1906

ANTHRACITE FIRE - AUGUST 4-11, 1906

GENERAL DESCRIPTION

The Castle Junction fire, also known as the Eldon fire, began on July 4 and its ignition close to the railway suggests it most likely started from sparks given off by passing trains (Crag and Canyon 1906). By the time it was extinguished on July 12 it had consumed 1,500 ha. Unfortunately, information regarding the ignition, behavior and cessation of this fire is scarce making the analysis difficult. Compounding this shortcoming is the total lack of June weather maps. The AES microfilm tapes record no June surface maps; the reasons for this are unknown. Therefore, this synoptic analysis will be primarily based on surface maps for May and July, Banff weather records and Banff drought codes.

SYNOPTIC SITUATION IN MONTHS PRECEDING THE CASTLE JUNCTION FIRE

Typically winter precipitation was below normal prior to a bad fire season; the winter of 1905/06 was no different. The months of December, 1905, January, 1906 and February, 1906 received 30.0, 51.3 and 36.4% of their normal precipitation. Table 3 and Graph 4 illustrate these precipitation trends. The total winter precipitation was therefore 39.2% of the norm. As spring came to the Rockies the moisture deficit worsened as March and April precipitation was 23.0 and 21.5 per cent of the respective norms.

As a result of this winter and spring moisture deficit start up drought codes were at an extreme value of 257.7 which was 202.4 points above normal. This extreme indicated a severe moisture deficit in deep duff layers and unless precipitation trends drastically increased a severe fire season was a distinct possibility. Finally in May badly needed precipitation reduced the hazard somewhat. In total May received 75.7 mm. of precipitation or 146% of the norm.

Table #3 - Banff Monthly Precipitation - 1906

Years	Month								Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	
1906	1.96	1.02	.48	.81	7.57	4.85	2.26	5.74	24.69
1951-1980	3.82	2.78	3.09	3.76	5.18	6.13	4.24	4.89	32.18
% of Norm	51.3	36.4	23.0	21.5	146.1	79.1	53.3	117.4	76.7

Note December 1905 1.14/3.79 = 30.0% of Norm

Graph #3 - Precipitation Trends - 1906

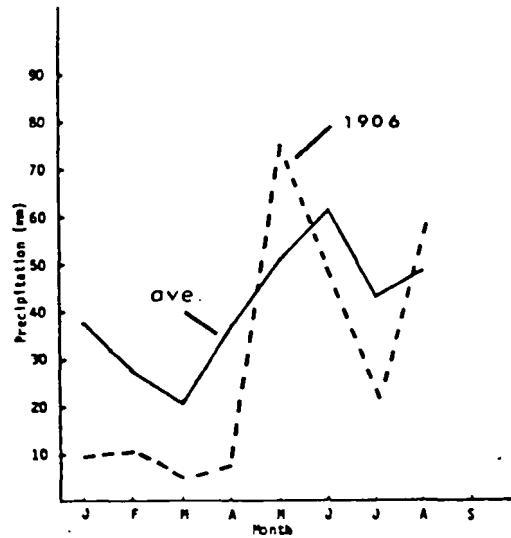


Table 4: -

*****BANFF NATIONAL PARK DROUGHT CODE VALUES*****

CARRY-OVER VALUE: 295-dc

Station is Banff; Overwinter Mean = 179mm
 Date Temp Rain D.C. Year = 1906

Date	Temp	Rain	D.C.	Year	Remarks
4 1	4.8	0.0	297.6		
4 2	2.6	0.0	299.0		
4 3	10.9	0.0	301.9		
4 4	11.4	0.0	304.9		

overwinter precip. = 55.8

Spring Start-up Value = 257.7

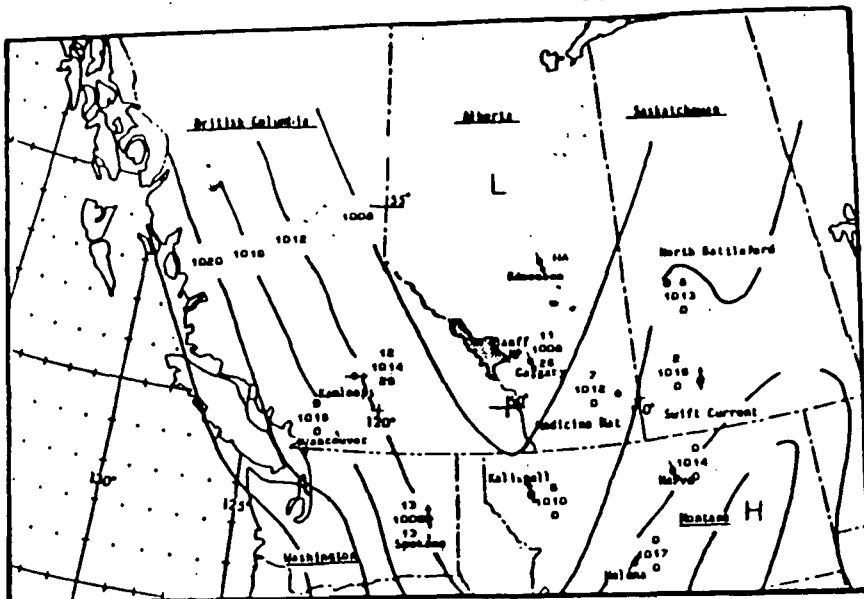
4 5	10.3	0.0	260.5	Low precipitation winter results in drought - code being 200 points above average
4 6	13.1	0.0	263.8	
4 7	9.8	2.0	266.5	
4 8	5.9	0.0	268.6	
4 9	3.7	1.0	270.2	
4 10	4.2	0.0	271.9	
4 11	2.6	0.3	273.3	
4 12	4.8	0.0	275.1	
4 13	8.1	0.0	277.5	
4 14	10.9	0.0	280.5	
4 15	14.8	0.0	284.1	
4 16	12.6	0.5	287.3	
4 17	4.8	1.0	289.1	
4 18	8.1	0.0	291.5	
4 19	10.3	0.0	294.3	
4 20	14.8	0.0	298.0	
4 21	19.8	0.0	302.5	
4 22	16.4	0.0	306.4	
4 23	12.6	1.8	309.6	
4 24	8.7	0.0	312.1	
4 25	6.4	0.8	314.2	
4 26	11.4	0.0	317.2	
4 27	7.6	0.0	319.6	
4 28	10.3	0.0	322.4	
4 29	16.4	0.0	326.3	
4 30	16.4	0.0	330.2	
5 1	13.7	9.9	305.0	Five major storm tracks over Banff during May - probably upper level persistent troughs.
5 2	12.6	0.0	309.7	
5 3	8.7	0.0	313.6	
5 4	4.8	0.0	316.9	
5 5	6.4	0.0	320.4	
5 6	4.2	0.0	323.6	
5 7	10.9	0.0	328.0	
5 8	16.4	0.0	333.3	Weak high
5 9	20.3	0.0	339.4	
5 10	20.9	0.0	345.6	
5 11	15.9	0.0	350.8	
5 12	12.6	9.4	325.7	Low pressure system
5 13	10.9	0.0	330.1	
5 14	13.1	0.0	334.8	
5 15	10.3	3.6	331.4	
5 16	2.6	5.3	320.4	Trough
5 17	7.6	2.0	324.2	
5 18	8.1	0.8	328.0	
5 19	12.6	0.0	332.7	Arctic high
5 20	13.7	1.5	337.6	
5 21	12.6	10.4	309.9	
5 22	2.6	14.0	270.8	Low pressure over Washington-Idaho, upslope winds and rain.
5 23	5.3	1.3	274.2	
5 24	7.0	9.4	253.1	
5 25	5.9	2.5	256.6	
5 26	3.1	0.0	259.5	

Date	Temp.	Rain	D.C.	Remarks
5 27	7.6	0.0	263.3	
5 28	6.4	0.0	266.9	
5 29	7.2	3.0	265.4	
5 30	9.2	2.5	269.4	
5 31	14.8	0.0	274.5	
6 1	15.3	0.0	280.6	Cool temperatures, 80% of normal precipitation during June.
6 2	16.4	0.0	287.0	
6 3	19.2	0.0	293.9	
6 4	17.0	2.8	300.3	
6 5	13.1	0.0	306.1	
6 6	12.6	0.0	311.8	
6 7	10.9	0.0	317.1	
6 8	10.9	0.0	322.5	
6 9	16.4	0.0	328.8	
6 10	17.6	3.0	330.0	
6 11	17.0	0.3	336.5	
6 12	17.0	2.5	342.9	
6 13	11.4	1.3	348.4	No weather maps available
6 14	10.9	0.5	353.2	
6 15	8.1	6.6	339.0	
6 16	13.1	0.0	344.8	
6 17	11.4	0.5	350.3	
6 18	12.6	0.5	355.9	
6 19	10.9	0.0	361.3	
6 20	13.1	0.0	367.1	
6 21	12.6	2.8	372.7	
6 22	9.2	1.4	326.6	
6 23	18.7	0.0	333.3	
6 24	23.1	0.0	340.9	
6 25	24.8	0.3	348.8	
6 26	21.4	0.3	356.0	
6 27	19.3	9.7	331.7	
6 28	12.6	1.8	337.4	
6 29	10.3	0.3	342.7	
6 30	16.4	0.0	349.0	
7 1	24.2	0.0	357.1	Strong high pressure system over Alberta southerly flow-hot dry winds
7 2	24.8	0.0	365.3	Eldon fire begins
7 3	25.9	0.0	373.6	
7 4	29.3	0.0	382.7	
7 5	27.0	0.5	391.3	extreme fire behavior - fire jumps river
7 6	28.7	0.0	400.1	
7 7	26.4	0.3	408.6	
7 8	26.4	1.8	417.0	low pressure, cold front passage
7 9	26.4	0.0	425.5	
7 10	21.4	0.8	433.0	clearing skies - coastal high
7 11	23.1	0.0	440.9	
7 12	21.4	0.8	448.5	Fire ends - moist low pressure moves inland, remains over prairies for several days.
7 13	13.7	8.6	420.7	
7 14	22.6	0.0	428.4	
7 15	25.9	0.0	436.8	
7 16	25.9	0.0	445.2	
7 17	23.7	1.8	453.1	
7 18	22.6	0.0	460.9	
7 19	20.9	0.0	468.4	
7 20	22.0	0.8	476.1	
7 21	23.1	0.0	483.9	
7 22	24.8	0.0	492.1	
7 23	23.1	0.0	499.9	
7 24	18.7	0.0	507.0	
7 25	20.3	0.0	514.4	
7 26	19.8	6.9	491.1	Upper level trough dominates over Alberta
7 27	23.1	0.0	499.0	
7 28	25.9	0.0	507.3	
7 29	26.4	0.0	515.3	
7 30	24.8	0.5	523.9	
7 31	19.2	0.0	531.1	Total July rainfall only 53% of average
8 1	18.7	0.0	537.5	high pressure system
8 2	29.2	0.5	545.7	
8 3	20.3	0.0	552.4	
8 4	22.0	0.0	559.4	Anthracite fire begins - warm low pressure system
8 5	19.2	0.0	565.8	
8 6	23.7	0.0	573.1	
8 7	24.8	0.0	580.6	
8 8	24.8	0.0	588.0	
8 9	23.7	0.0	595.3	high pressure moves over Alberta.

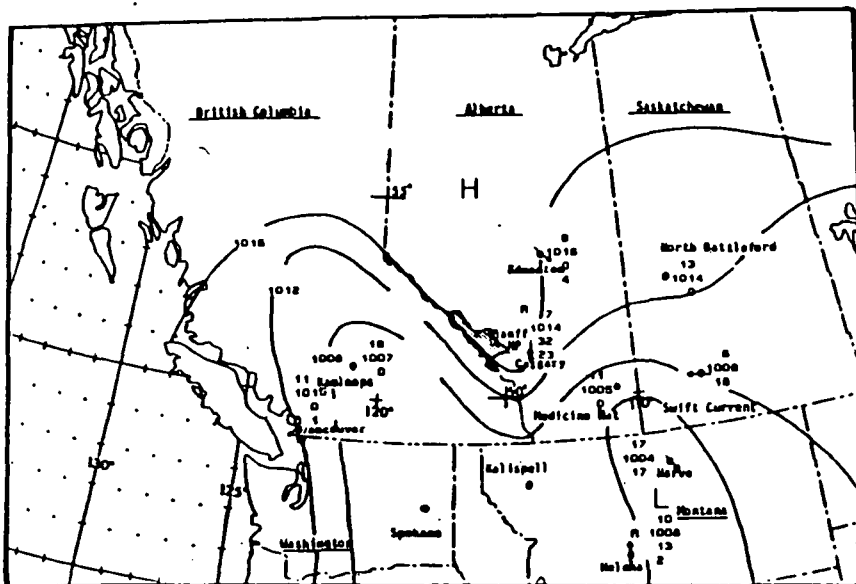
Date	Temp.	Rain	D.C.
8 10	26.4	0.0	603.0
8 11	27.0	0.0	610.9
8 12	27.2	0.5	618.7
8 13	17.0	1.0	624.4
8 14	15.3	0.0	630.2
8 15	13.7	9.1	580.0
8 16	18.7	0.0	586.3
8 17	19.8	0.0	592.9
8 18	17.0	1.5	599.0
8 19	13.1	9.1	552.5
8 20	11.4	1.3	557.6
8 21	3.7	16.3	474.2
8 22	9.2	2.5	478.9
8 23	15.9	0.0	484.7
8 24	15.3	1.9	437.3
8 25	14.2	3.6	432.9
8 26	17.6	0.0	439.0
8 27	17.6	0.0	445.2
8 28	14.8	0.0	450.9
1 8 29	19.8	0.0	457.4
8 30	22.0	0.0	464.4
8 31	18.7	0.0	470.8
9 1	15.9	0.0	475.3
9 2	17.6	0.0	480.2
9 3	17.0	0.0	485.0
9 4	17.0	0.0	489.7
9 5	15.3	0.0	494.2
9 6	16.4	0.0	498.9
9 7	16.4	0.3	503.5
9 8	15.3	7.6	474.5
9 9	7.6	0.5	477.6
9 10	8.1	0.0	480.7
9 11	8.7	0.0	484.0
9 12	6.4	0.0	486.8
9 13	9.2	0.0	490.2
9 14	10.3	0.0	493.8
9 15	12.6	0.0	497.7
9 16	13.7	0.0	501.9
9 17	14.8	0.0	506.3
9 18	19.2	0.0	511.4
9 19	20.9	0.0	516.9
9 20	12.6	0.0	520.9
9 21	8.1	0.0	524.0
9 22	13.1	0.0	528.1
9 23	18.1	0.0	533.1
9 24	9.8	3.3	525.7
9 25	6.4	1.0	528.6
9 26	13.1	0.0	532.6
9 27	10.3	0.3	536.2
9 28	9.8	0.5	539.7
9 29	16.4	0.0	544.3
9 30	15.9	0.3	548.9
10 1	13.1	0.3	551.9
10 2	10.9	1.5	554.6
10 3	5.9	5.3	532.5
10 4	4.8	0.0	534.0
10 5	9.2	0.0	536.4
10 6	12.5	0.0	539.4
10 7	10.9	0.8	542.0
10 8	4.8	0.0	543.6
10 9	16.4	0.0	547.2
10 10	16.4	0.0	550.9
10 11	13.1	2.3	554.0
10 12	8.1	0.0	556.1
10 13	9.2	0.0	558.5
10 14	6.4	0.3	560.3
10 15	5.9	0.5	562.1
10 16	5.3	2.5	563.8
10 17	4.8	0.0	565.3
10 18	4.2	1.3	566.8
10 19	0.9	7.6	528.7

Rire ends

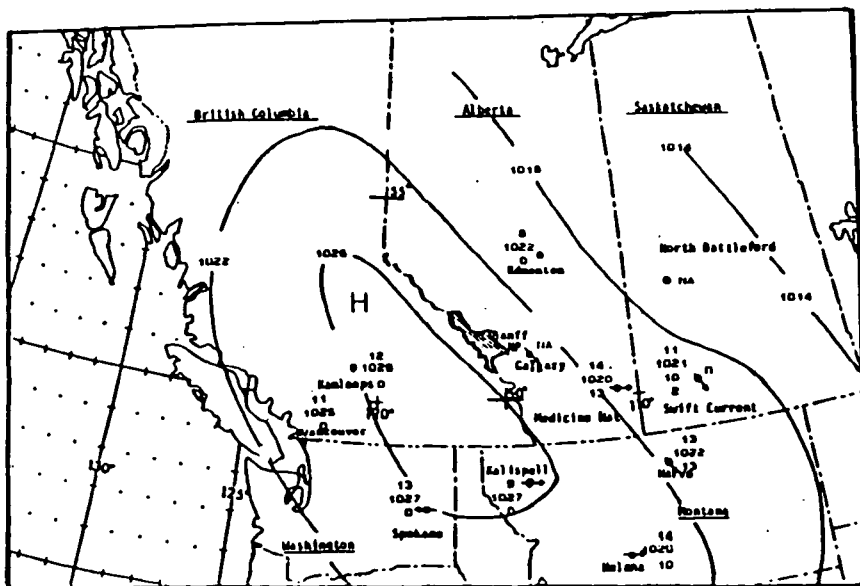
Remarks



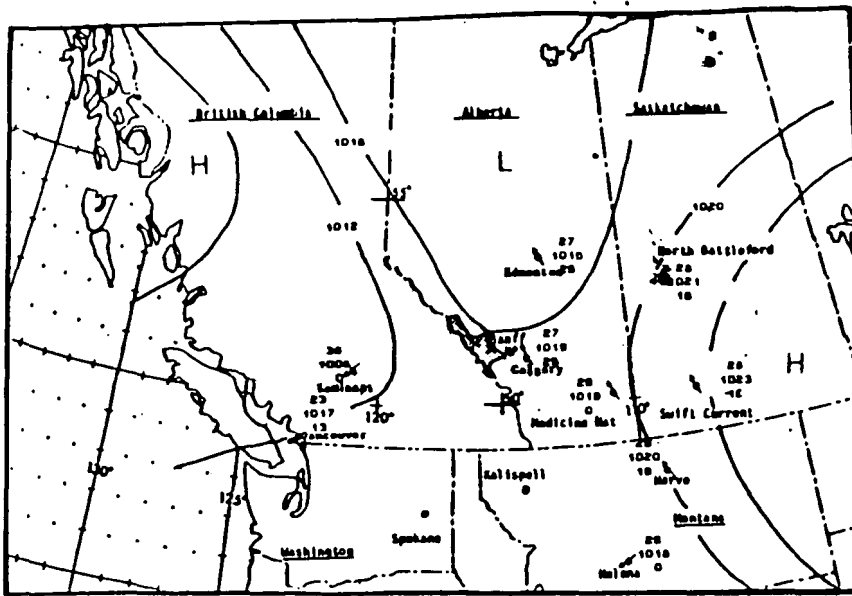
Map # 25: Surface Map:
May 1, 1906 - 8:00 p.m.



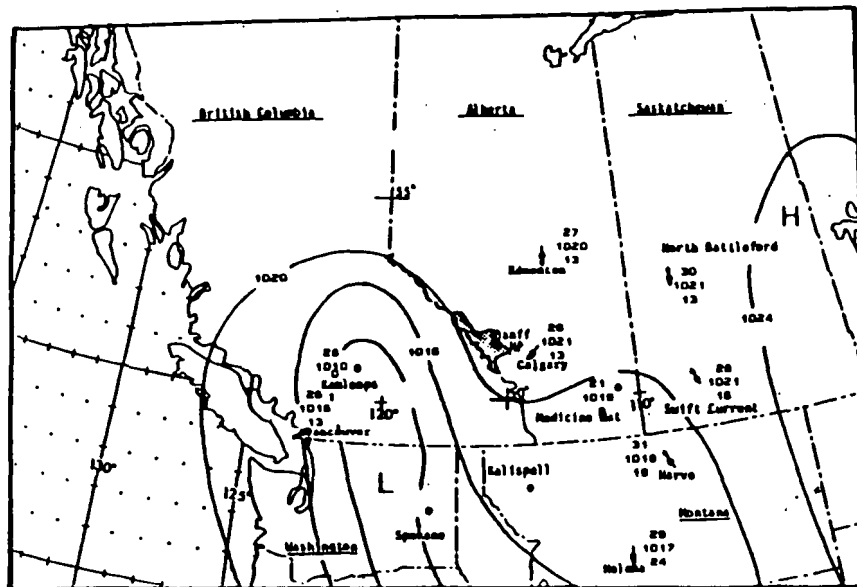
Map # 26: Surface Map:
May 21, 1906 - 8:00 p.m.



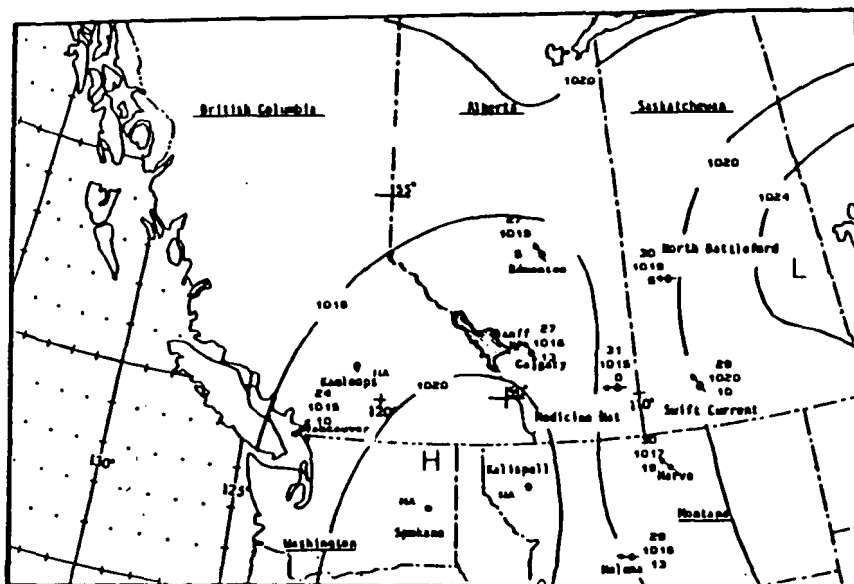
Map # 27: Surface Map:
July 1, 1906 - 8:00 a.m.



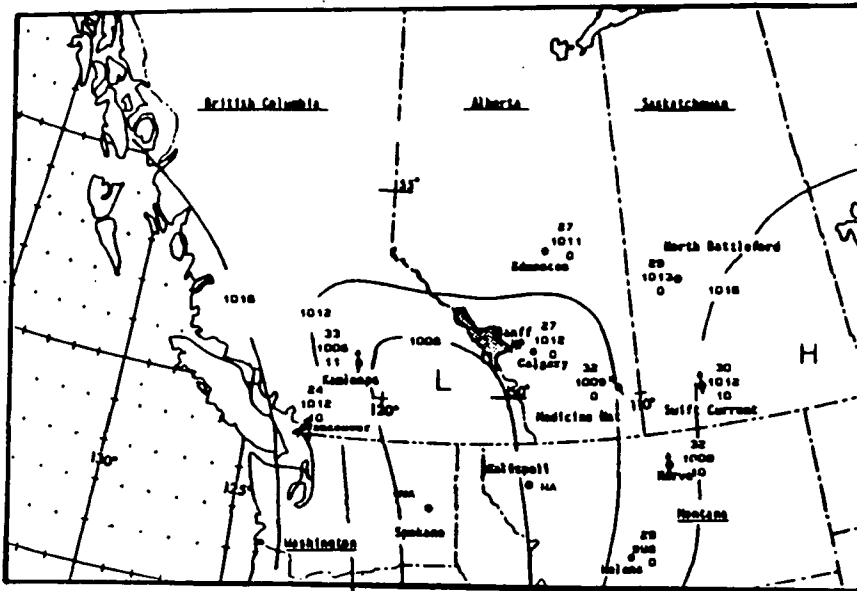
Map # 28: Surface Map:
July 4, 1906 - 8:00 p.m.



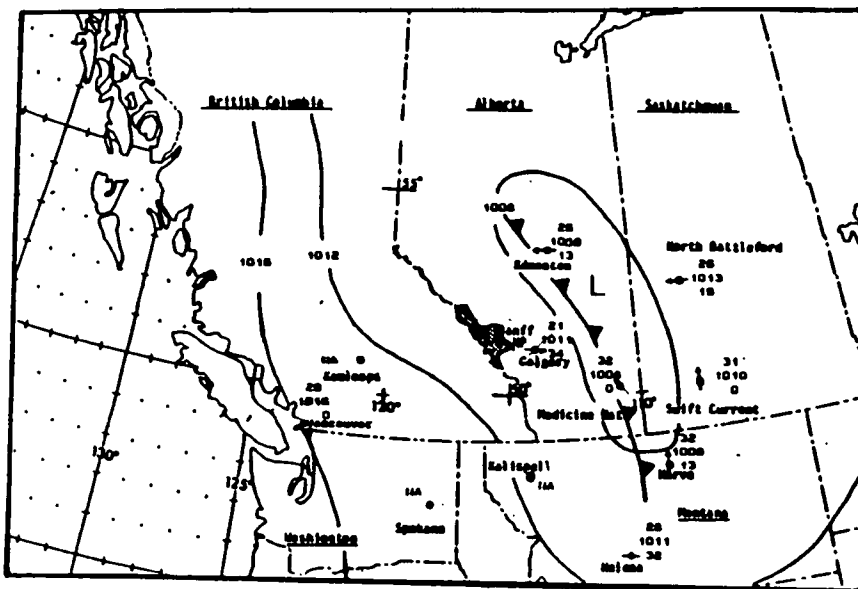
Map # 29: Surface Map:
July 5, 1906 - 8:00 p.m.



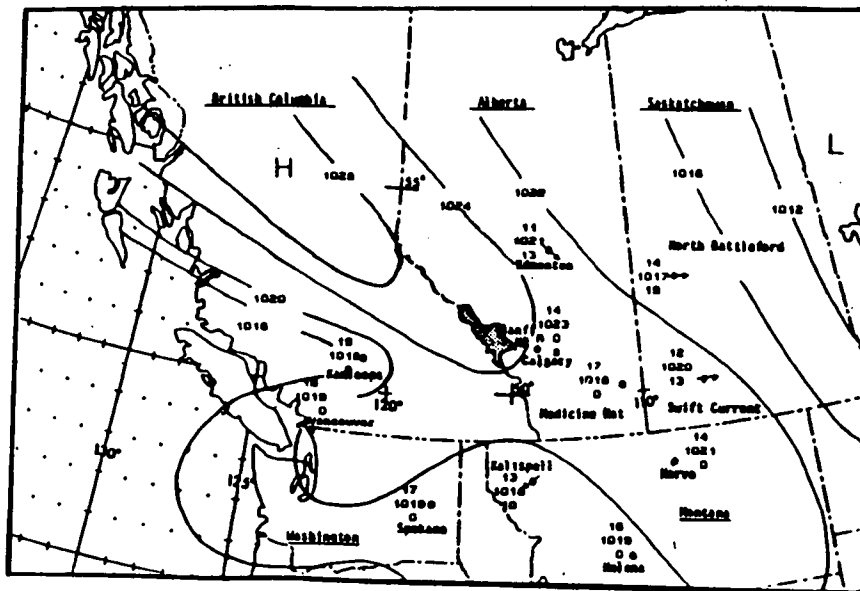
Map # 30: Surface Map:
July 6, 1906 - 8:00 p.m.



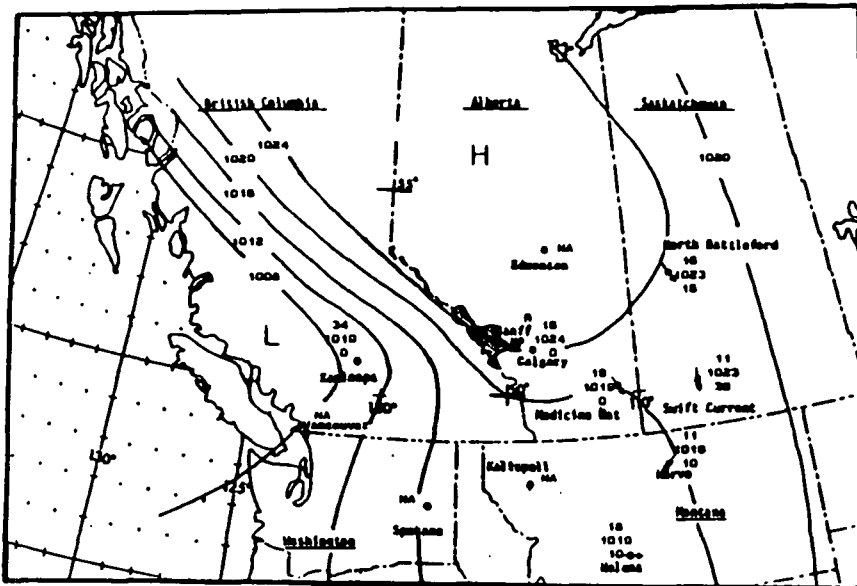
Map # 31: Surface Map:
July 7, 1906 - 8:00 p.m.



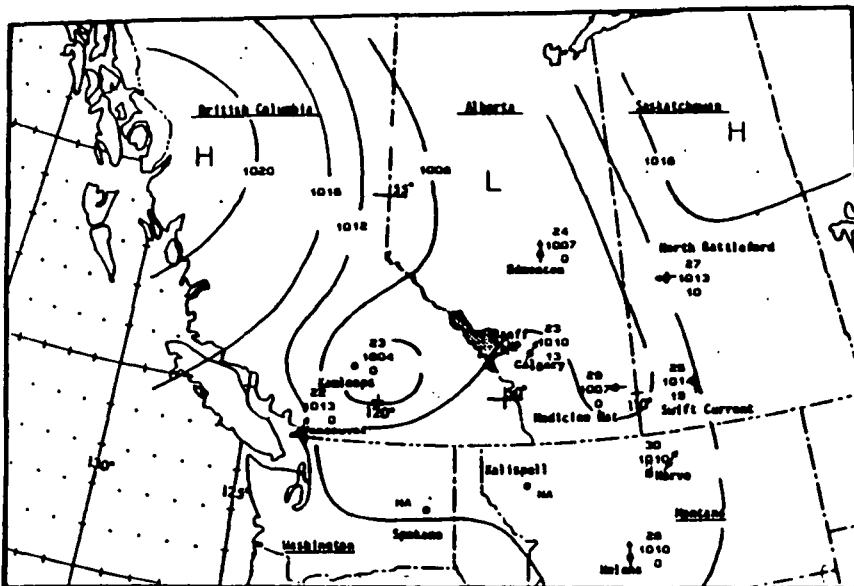
Map # 32: Surface Map:
July 8, 1906 - 8:00 p.m.



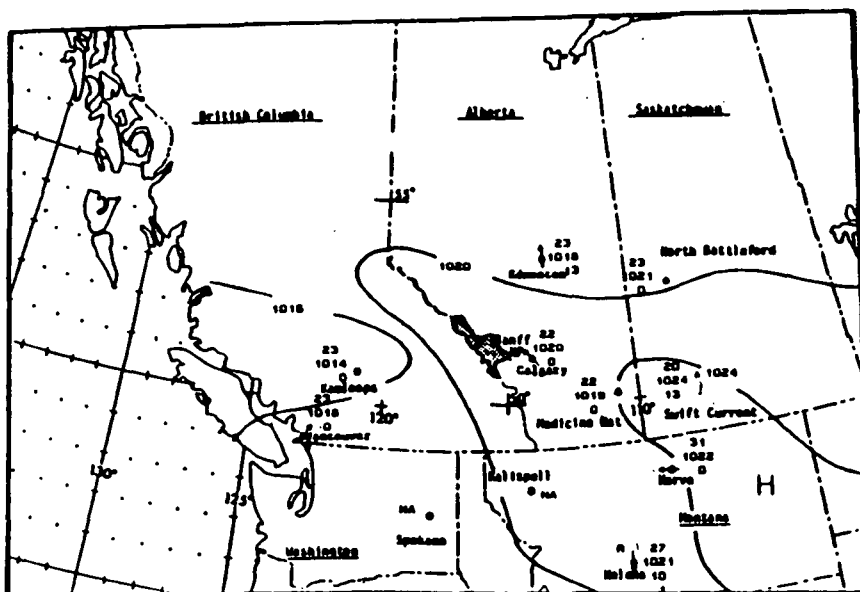
Map #33: Surface Map:
July 12, 1906 - 8:00 p.m.



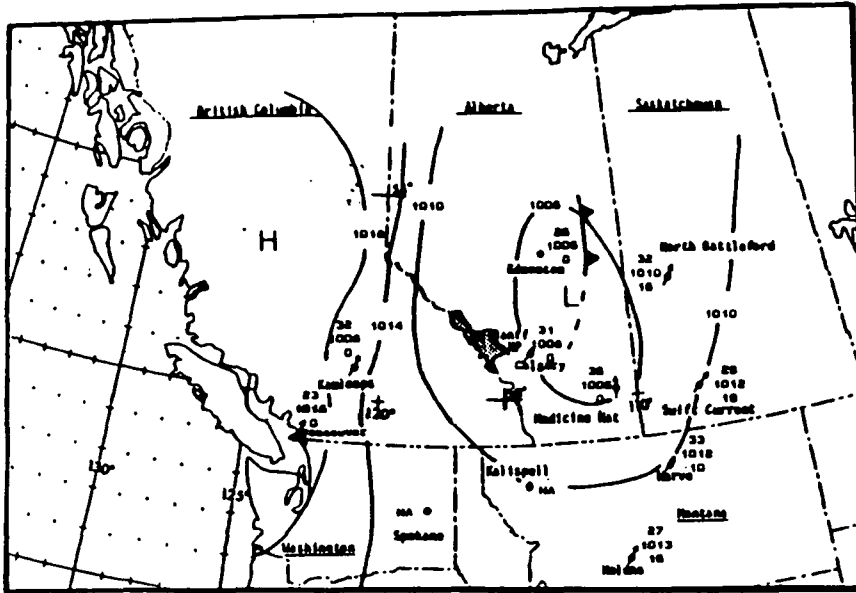
Map # 34: Surface Map:
July 13, 1906 - 8:00 p.m.



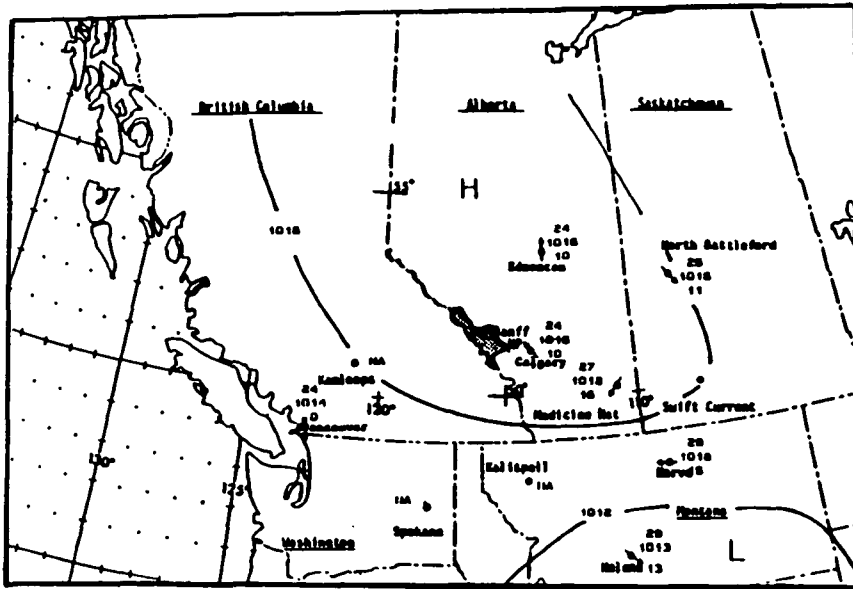
Map # 35: Surface Map:
July 16, 1906 - 8:00 p.m.



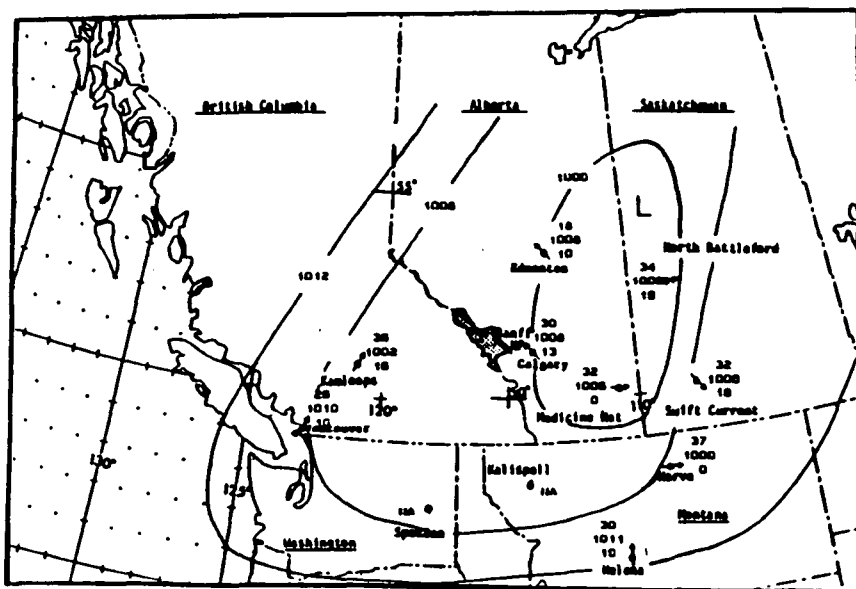
Map # 36: Surface Map:
August 3, 1906 - 8:00 p.



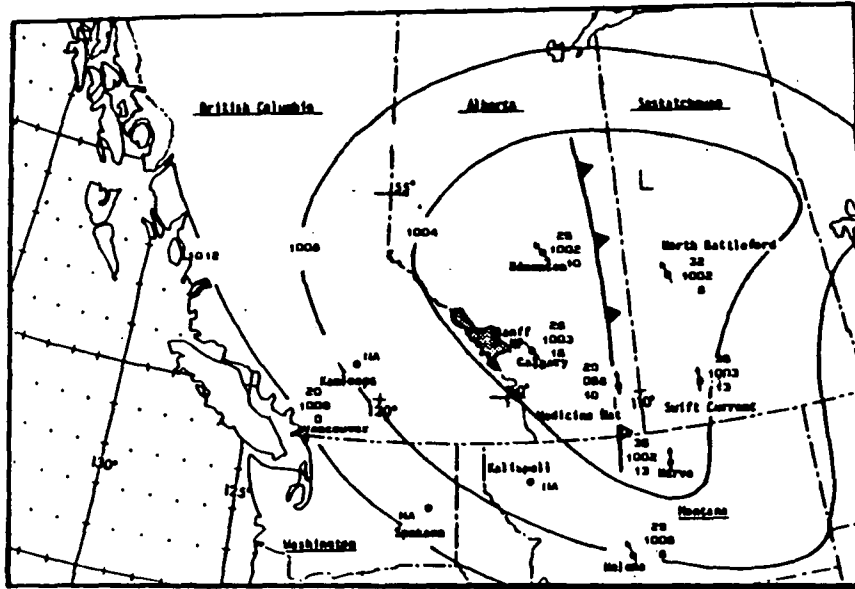
Map # 37: Surface Map:
August 7, 1906 - 8:00 p.



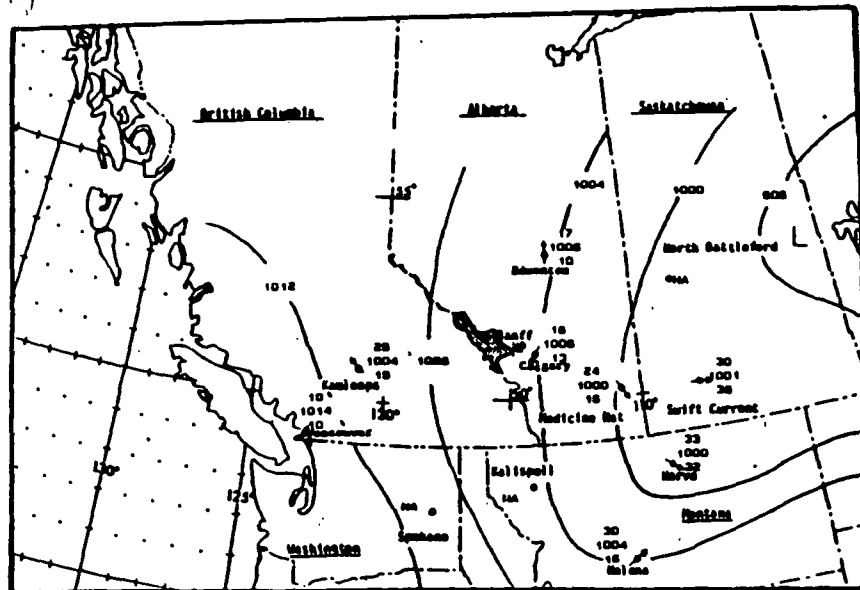
Map # 38: Surface Map:
August 9, 1906 - 8:00 p.



Map # 39: Surface Map:
August 11, 1906 - 8:00 p.



Map # 40: Surface Map:
August 12, 1906 - 8:00 p



Map # 41: Surface Map:
August 15, 1906 - 8:00 p

Five major storms occurred in May. The first on May 1st was brought about by the intrusion of a trough into Alberta from the Northwest Territories and brought 9.9 mm. of precipitation to Banff (see Map # 25). Temperatures remained cool through the 1st week of May until the 8th as Banff was under a weak high pressure when temperatures began to rise. On the 9th the high lay directly over Banff and as clear skies prevailed temperatures rose to 20⁰C by mid-day. This system remained quasi-stationary on the 10th and temperatures remained warm. As barometric pressure fell on the 11th so did temperatures and by the 12th Banff's weather was dominated by a low pressure system. As temperatures fell to the low teens 9.4 mm. of rain was recorded in Banff. Temperatures remained cool as this low tracked northeast on the 13th and 14th. By the 16th Banff's weather was again dominated by a trough and as winds were from the north-northeast temperatures dipped to a low 2.6⁰C and 5.3 mm. of rain fell in Banff. As this low weakened, temperatures rose. An Arctic high pressure system tracked southwards over the prairie provinces on the 19th and 20th and dominated weather raising temperatures to the mid-teens. On the 21st (Map 26) , a low pressure system moved in off the U.S. coast and lay over Washington, Idaho and Montana. This system promoted upslope winds in southern Alberta and as it confronted the Arctic high temperatures again began to fall and Banff recorded 10.4 mm. of rain. This synoptic situation remained stationary until the 26th and as a result temperatures fell to a low 2.6⁰C on the 22nd and 14.0 mm. of rain was recorded in Banff. In total, this synoptic pattern brought 39.1 mm. of rain from May 20 to May 25th. This pattern brought five days of inclement weather making it the most significant May disturbance. Weather remained cool throughout the rest of the month with another weak disturbance bringing 5.5 mm. on the 29th and 30th. On the 31st a weak high lay over southern Alberta and B.C. and under clear skies the temperature reached the mid-teens.

May had been an unusually cool wet month. Temperatures rose above the average daily high on only four days with the average high temperature being 5⁰C below normal. This trend in accordance with

146% of the month's normal precipitation was undoubtedly the product of an upper trough persisting throughout the month.

The month of June although being cool received 80% of the month's normal precipitation. The first two weeks were dominated by unstable but never severe weather. Temperatures remained in the mid-teens and a few millimeters of rain fell every four or five days. On the 15th a minor disturbance brought 6.6 mm. of rain to Banff and dropped temperatures to 8.1⁰C. The remaining two weeks of June experienced fluctuating temperatures and two major disturbances brought 14.7 and 9.7 mm. of rain on the 22nd and 27th respectively.

Synoptic patterns which led to this month's weather are unknown due to their non-existence on micro film.

SYNOPTIC SITUATION IMMEDIATELY PRECEDING AND DURING THE CASTLE JUNCTION FIRE

The coming of July brought warm temperatures to Banff. On July 1st as British Columbia and Alberta lay under a strong high (Map # 27) temperatures rose to the mid-twenties. As this system tracked southeast and warmed, a low off the coast amplified the southerly flow of hot dry winds and temperatures continued to rise on the 2nd, 3rd and 4th. By the 4th as southern Alberta continued to experience a hot, dry southerly flow a trough intruded over northern Alberta (Map # 28). July 4th was believed to be the ignition day of the Castle Junction fire; the ignition source was believed to be a passing train. As a result of low winter and spring precipitation and high July temperatures drought codes had reached 382.7, a value 120 points above normal. This high value indicates a significant moisture deficit in deep duff layers and forest fuels.

With temperatures being hot, 29.8⁰C, and winds being from the south the fire spread rapidly and quickly became uncontrollable. On the 5th, synoptic patterns suggest weather was similar to the 4th in the Bow Valley. A low pressure system over B.C. intensified the southerly flow

(Map # 29). By the 6th (Map # 30) the low had completely broken down and been replaced by a weak high. Winds were most likely from the northwest throughout the day and the fire jumped the river to the south side. Temperatures remained hot as Banff was under predominantly clear skies. Winds were again from the south on the 7th as a low pressure system developed over southern B.C. and Washington, (Map #31). As a result of the shifting winds of the last few days the fire burned in no particular direction with intensities fluctuating in response to wind shifts. It continued to increase in size and most likely had several fire fronts.

The low pressure system of the 7th tracked eastward and by the evening of the 8th lay over southeastern Alberta (Map # 32). With this low came a well defined cold front which probably passed over the fire sometime during the afternoon of the 8th. An increase in fire intensity probably accompanied the cold front passage but no records of fire behavior are available to verify the occurrence. Following the passage of this front 1.8 mm. of rain fell in Banff. In all likelihood precipitation probably fell at Castle Junction but the extent of rain is unknown. Accompanying this rain was a shift in wind direction to the northwest. As this occurred fire intensity diminished. By the 9th the low lay over B.C., Alberta and Saskatchewan and the weather remained unchanged from the 8th.

SYNOPTIC SITUATION AT THE END OF THE CASTLE JUNCTION FIRE

Throughout July 10th the low pressure system continued to track northeast as a maritime high pressure system moved inland over the British Columbia coast. Temperatures fell to 21.4⁰C along with .8 mm. of rain on the 10th. By the 11th winds were out of the northeast and temperatures in Banff increased slightly as clear skies prevailed. As the coastal high continued to develop on the 12th (Map # 33) temperatures again dipped to 21.4⁰C and another .8 mm. of rain fell in Banff. Falling temperatures in conjunction with higher humidities, northeast winds and light rain assured the control of the Castle Junction fire. By the evening of the

13th the high lay over northern Alberta and a moist low moved inland over British Columbia (see Map # 34).

As temperatures fell to 13.7°C, 8.6 mm. of rain fell in Banff. This precipitation was a result of upslope winds and a confrontation between the moist low and cool high pressure system. The cool temperatures in conjunction with heavy rains brought about the denouement of the Castle Junction fire.

SYNOPTIC SITUATION PRECEDING AND DURING THE ANTHRACITE FIRE

The low pressure system that lay off the coast of British Columbia on the 13th tracked east and by the 16th lay over Alberta (Map # 35). As it tracked east southern Alberta lying in the warm sector experienced temperatures in the mid to high 20's. As it continued to track east on the 17th temperatures fell to the low twenties. The low remained quasi-stationary over the prairies for the next few days and dominated weather. Temperatures remained in the low 20's and 2.6 mm. of rain fell on the 17th and 20th. These rains had little effect on drought code values and they continued to rise throughout the month. Barometric pressures remained low throughout most of the month and temperatures remained in the low and mid-twenties. Rain fell on the 26th in Banff as a trough dominated weather in Alberta.

On July 28 a high pressure system over southern Saskatchewan, Montana and the Dakotas promoted a strong southerly flow into Alberta and temperatures rose to 26°C on the 28th and 29th. On the 31st an intense low over Alberta yielded a northerly flow and temperatures fell to 19°C.

July had been a relatively warm month as 22 days experienced temperatures which exceeded the average daily high and the monthly high was 1.3°C above normal. The month also experienced a significant moisture deficit; a total precipitation of 53% of the norm. The drought code as a result reached a value of 531.1, 142.2 points above normal. This high value signified a significant moisture deficit and fire hazard. The cause

of such weather and production of such a fire hazard was probably the result of an upper blocking high.

August 1st was cool as the low of the 31st continued to dominate weather but by the 2nd a high pressure system brought clearing skies and temperatures soared up to 29⁰C. On the 3rd this system still persisted over Alberta (Map # 36) but temperatures were a cool 20⁰C. On the 4th as the previous day's high moved southeast a trough extended into Alberta from the Northwest Territories. Winds were from the south-southeast and temperatures in Banff reached 22⁰C. The 4th is believed to be the ignition day of the Anthracite fire with the ignition source believed to be related to settlement (White 1982). The drought code had a value of 559.4 which was 160 points above normal and the fire season still was troublesome.

Fire intensity was not extreme but southerly winds fanned the fire and was not controlled. The low of the 4th continued to dominate weather on the 5th and 6th. Winds continued from the east-southeast. By the 7th (Map # 37) the low of the 6th had continued to build and lay over Alberta. Winds were from the southwest as a weak cold front stretched through Alberta west of Calgary. Increased winds behind this cold front resulted in increasing fire intensity and prompted by west-southwest winds the fire burned to the northeast. On August 8th as the previous days low tracked east a high pressure system moved inland over B.C. Barometric pressure continued to rise throughout the 9th and winds were out of the northwest. By the evening the high lay directly over Alberta (Map # 38) and winds again shifted to the southeast. This high tracked quickly east on the 10th as a low moved in off the coast and by the evening lay directly over the B.C.-Alberta border. As Banff was in the warm sector of this low, temperatures rose to 26.4⁰C. This low continued to track east over Alberta and Saskatchewan on the 11th (Map # 39).

SYNOPTIC SITUATION AT THE END OF THE ANTHRACITE FIRE

On August 12th the previous day's low regressed back into Alberta and intensified (Map # 40). Winds were from the northeast and although temperatures remained warm .5 mm. of precipitation was recorded in Banff. Temperatures fell to a low 17⁰C on the 14th and 1.0 mm. of rain fell in Banff. Falling temperatures and rain assured easy control of the Anthracite fire which was 900 ha. The synoptic situation remained similar throughout the 14th as the low tracked northeast. On the 15th (Map # 41) this low still dominated weather in Alberta and as winds came from the northeast temperatures fell to 13.7⁰C and 9.1 mm. of rain assured the termination of the Anthracite fire.

CASTLE JUNCTION FIRE - AUGUST 8, 1908

GENERAL DESCRIPTION

The year 1908 was by no means a dry year. In fact, 117% of the normal precipitation fell between January 1 and August 31. Even though this above normal precipitation trend occurred a notable fire season occurred in the Bow Valley with 8000 ha. of forest being consumed by three major fires (White, 1982). On July 26 a fire started on the west side of Goat Mountain and eventually burned 3000 ha. before being extinguished. Then on August 8-10 another fire started near Castle Junction and its ignition source is believed to have been lightning. Before its termination this conflagration burned 5000 ha. Banff was not the only area which recorded a bad fire season; the Crowsnest Pass region recorded August fires which burned vast areas and killed numerous people.

This analysis will examine synoptic factors which led to the occurrence of the Castle Junction Fire. Information regarding the Spray Valley fire is sketchy and this fire will therefore not be discussed at great length within this analysis. This analysis is based solely on Banff weather data and historic surface maps. No additional weather information was located for 1908.

SYNOPTIC SITUATION IN MONTHS PRECEDING FIRE

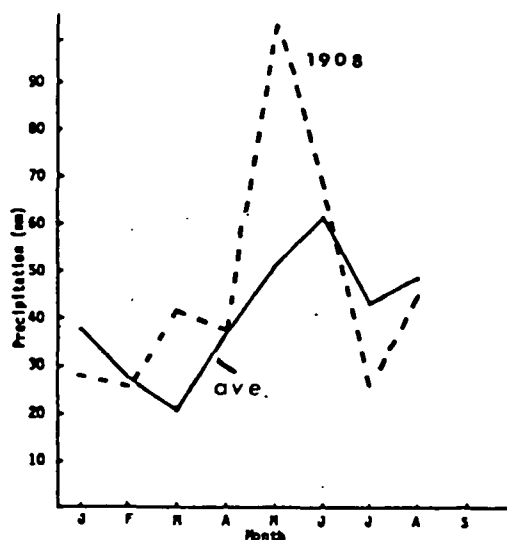
As previously stated 1908 was not a dry year. Overwinter precipitation was slightly less than the normal with December, 1907, January, 1908 and February, 1908 receiving 76.5, 73.8 and 96.7 per cent of their normal precipitation. Spring skiing in Banff would have been excellent as March recorded twice its normal precipitation and April recorded average precipitation for the month. As a result the spring start up drought code had a value of 70.8 which was just 15 points above normal. Table # 5 and Graph # 4 reveal the precipitation trends throughout the year and reveal that as the month of May passed over twice the normal monthly precipitation was recorded in Banff.

Table #5 - Banff Monthly Precipitation - 1908

Year	Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
1908		2.82	2.69	4.17	3.76	10.52	6.63	2.69	4.42	37.70
Average 1951-1980		3.82	2.78	2.09	3.76	5.18	6.13	4.24	4.89	32.18
% of Norm		73.8	96.7	200.0	100	2.03	1.08	63.4	90.38	117.2%

Note: December/07 Precipitation $2.9/3.79 = 76.5\%$ of Norm

Graph #4 - Precipitation Trends - 1908



 *****BANFF NATIONAL PARK DROUGHT CODE VALUES*****

CARRY-OVER VALUE: 0-dc

Station is Banff; Overwinter Mean = 179mm
 Year = 19 8

4	1	-3.0	0.0	0.4
4	2	4.2	0.0	2.2
4	3	5.3	1.8	4.1
4	4	-1.3	0.5	4.8
4	5	-0.2	0.3	5.7
4	6	-3.0	1.3	6.2
4	7	2.6	0.3	7.6
4	8	6.4	0.0	9.7
4	9	4.2	0.0	11.4
4	10	4.8	2.8	13.2
4	11	8.7	0.0	15.7
4	12	8.7	0.0	18.3
4	13	10.3	0.0	21.1
4	14	5.9	0.0	23.1
4	15	10.3	0.0	25.9
4	16	8.7	0.0	28.4
4	17	3.7	1.3	30.0
4	18	7.0	1.0	32.2
4	19	9.2	1.0	34.8
4	20	9.3	9.1	24.3

overwinter precip.=162.4

Spring Start-up Value= 70.8 *Average or above average precipitation throughout winter*

4	21	12.0	0.0	73.9
4	22	12.0	0.0	77.0
4	23	7.0	4.8	72.8
4	24	3.7	3.8	70.0
4	25	4.2	6.4	62.3
4	26	8.7	0.0	64.8
4	27	6.4	1.8	67.0
4	28	6.4	1.5	69.1
4	29	7.0	0.0	71.3
4	30	12.0	0.0	74.4
5	1	15.3	0.0	79.5
5	2	13.1	0.0	84.3
5	3	8.7	3.0	85.3
5	4	10.9	0.0	89.7
5	5	14.8	0.0	94.8
5	6	18.7	0.0	100.5
5	7	19.2	0.0	106.4
5	8	10.3	25.1	63.3
5	9	4.2	0.0	67.4
5	10	7.6	7.1	60.5
5	11	10.3	7.9	52.8
5	12	7.0	13.2	35.3
5	13	6.4	3.6	35.2
5	14	5.9	1.0	38.7
5	15	7.6	0.5	42.4
5	16	7.0	9.4	32.1
5	17	8.7	1.8	36.0
5	18	5.9	1.8	39.5
5	19	4.8	2.8	42.8
5	20	8.7	0.3	46.7
5	21	11.4	0.0	51.2
5	22	12.0	0.0	55.8
5	23	13.1	0.0	60.5
5	24	13.1	0.0	65.3
5	25	10.3	11.7	50.4
5	26	7.0	1.3	54.1

Five major cyclonic disturbances in May result in above average precipitation

Low pressure system squeezed between two highs

Trough from Northwest Territories extends into Alberta

5	27	9.8	0.0	58.3
5	28	15.3	0.0	63.4
5	29	11.4	0.0	67.9
5	30	9.8	10.4	55.2
5	31	7.6	4.1	54.2
6	1	7.6	13.5	37.2
6	2	10.3	2.3	42.5
6	3	11.4	1.0	47.9
6	4	9.2	2.5	53.0
6	5	12.0	0.0	58.5
6	6	12.0	1.5	64.1
6	7	14.8	0.5	70.2
6	8	19.8	0.0	77.1
6	9	20.3	0.5	84.2
6	10	19.8	0.0	91.2
6	11	15.3	6.4	87.4
6	12	13.1	0.0	93.2
6	13	15.9	0.0	99.5
6	14	19.8	0.5	106.4
6	15	18.1	0.5	113.1
6	16	14.2	0.0	119.1
6	17	13.1	0.0	124.8
6	18	14.8	0.0	130.9
6	19	10.9	1.3	136.3
6	20	10.3	3.0	138.2
6	21	5.3	11.4	120.4
6	22	12.6	0.0	126.0
6	23	15.9	0.0	132.3
6	24	21.4	0.0	139.6
6	25	20.9	1.8	146.7
6	26	17.6	14.0	124.9
6	27	5.3	5.6	120.3
6	28	12.0	0.0	125.9
6	29	14.2	0.0	131.8
6	30	15.3	0.0	138.0
7	1	22.0	0.0	145.6
7	2	22.6	1.5	153.4
7	3	16.4	0.0	160.1
7	4	13.1	0.8	166.1
7	5	14.8	0.0	172.5
7	6	19.2	0.0	179.7
7	7	22.0	0.0	187.3
7	8	22.0	0.0	195.0
7	9	19.8	0.0	202.3
7	10	22.0	0.0	209.9
7	11	24.8	0.0	218.1
7	12	22.0	0.0	225.8
7	13	17.0	2.0	232.5
7	14	16.4	5.3	228.3
7	15	21.4	1.3	235.9
7	16	19.2	0.3	243.0
7	17	21.4	1.0	250.6
7	18	22.0	1.8	258.2
7	19	22.6	0.0	266.0
7	20	25.9	0.0	274.4
7	21	28.1	0.0	283.1
7	22	27.6	0.0	291.8
7	23	24.2	4.1	291.3
7	24	22.6	0.0	299.0
7	25	18.7	1.5	306.1
7	26	15.9	0.0	312.7
7	27	13.7	0.0	319.7
7	28	14.8	7.4	305.3
7	29	17.6	0.0	312.2
7	30	23.1	0.0	320.1
7	31	26.4	0.0	328.5
8	1	24.2	2.5	335.9
8	2	17.0	0.5	341.9
8	3	18.1	0.0	348.2
8	4	22.6	0.0	355.3
8	5	24.2	0.0	362.6
8	6	22.6	0.0	369.7
8	7	21.4	0.8	376.6
8	8	24.2	0.0	383.9
8	9	23.1	0.0	391.1
8	10	19.8	0.0	397.6
8	11	13.7	9.1	371.0
8	12	14.8	1.3	376.7
8	13	16.4	0.8	382.6

June weather remains cool and moist due to possible upper trough

Intense low develops over prairies resulting in upslope conditions and rain

High pressure system over the prairies results in a warm southerly airflow over BWP
Trough pushes in from Northwest Territories

High situated over B.C.-Alberta border

High situated over Saskatchewan-U.S. border

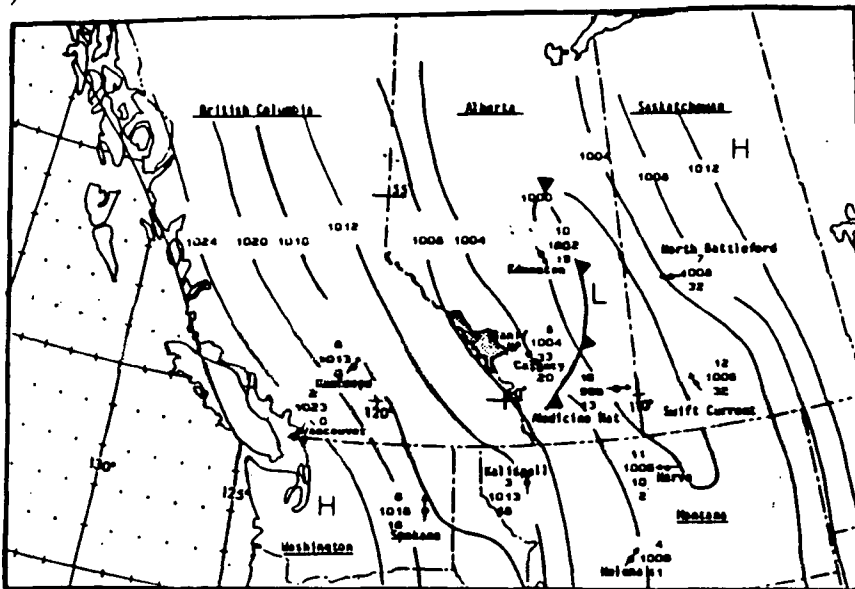
High tracked east over Alberta, S winds, Spray River fire starts
Low pressure, NE winds, fire quiet
High over Dakotas moderate fire intensity
Well defined low pressure cell brings precipitation

High builds in, possible instabilities could have caused lightning
Trough invades from Yukon with cold fronts, W winds drive Castle Fire 12 Km
North upslope winds results in major rainfall, no further fire spread

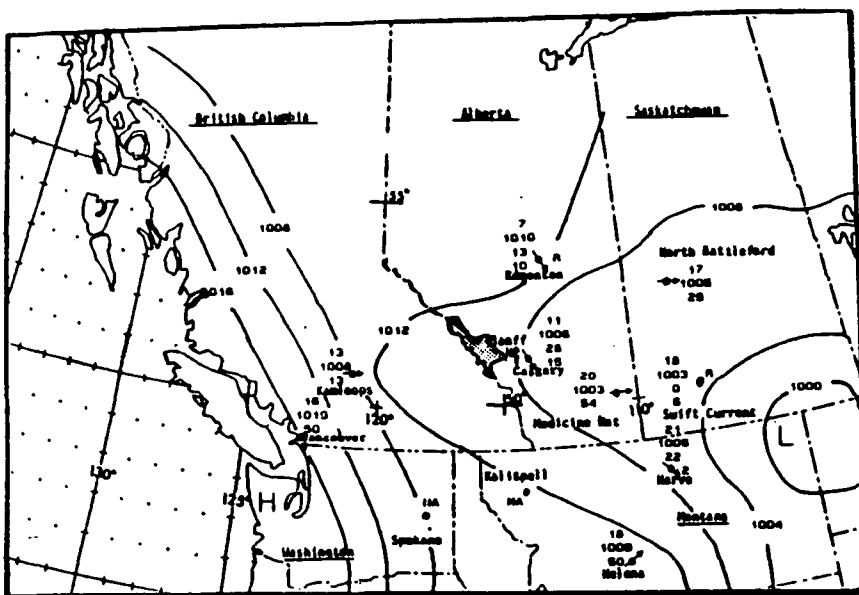
8	14	21.4	0.0	389.5
8	15	21.4	0.0	396.4
8	16	18.1	0.0	402.6
8	17	24.8	0.0	410.1
8	18	22.0	0.0	417.0
8	19	26.4	0.0	424.8
8	20	22.0	0.0	431.8
8	21	18.7	0.0	438.1
8	22	22.0	0.0	445.1
8	23	19.2	12.4	400.9
8	24	13.7	2.0	406.3
8	25	5.3	9.9	374.2
8	26	9.2	1.3	378.9
8	27	13.7	0.5	384.3
8	28	12.6	0.0	389.6

Rain reduced fire danger for remainder of year

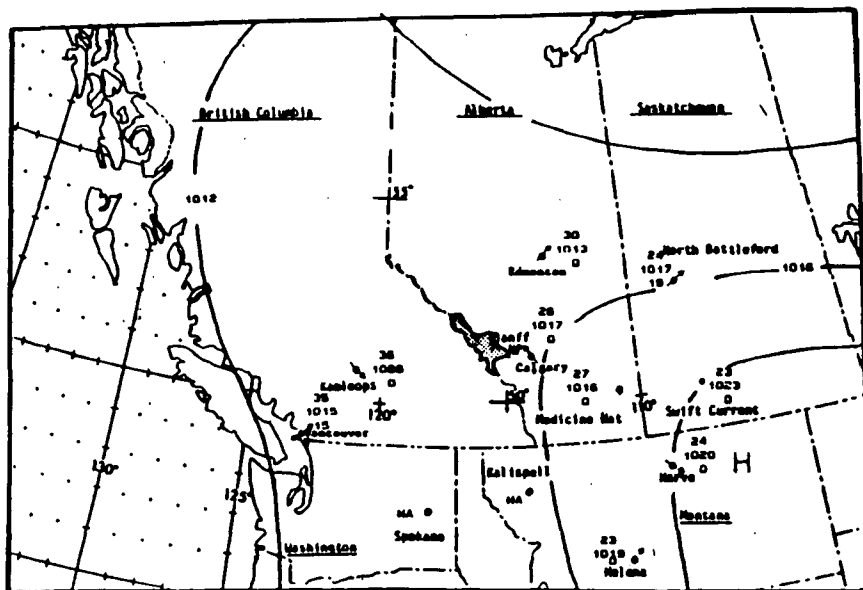
1	8	29	11.4	0.0	394.7
	8	30	10.3	2.0	399.5
	8	31	13.7	1.0	405.0
	9	1	16.4	0.0	409.7
	9	2	13.7	1.0	413.8
	9	3	14.2	1.5	418.1
	9	4	17.6	0.0	423.0
	9	5	19.8	0.0	428.2
	9	6	22.0	0.0	433.9
	9	7	19.8	13.0	387.2
	9	8	8.7	2.5	390.5
	9	9	8.7	0.0	393.8
	9	10	16.4	0.0	398.4
	9	11	19.8	0.0	403.7
	9	12	20.9	0.0	409.2
	9	13	20.9	0.0	414.6
	9	14	18.1	0.5	419.6
	9	15	14.2	3.0	417.1
	9	16	9.2	11.4	377.1
	9	17	14.2	0.0	381.4
	9	18	9.2	0.0	384.7
	9	19	13.7	0.0	388.9
	9	20	15.3	0.0	393.4
	9	21	14.8	0.0	397.7
	9	22	10.9	0.3	401.4
	9	23	3.1	0.8	403.6
	9	24	-3.0	1.5	404.8
	9	25	1.4	0.3	406.8
	9	26	2.0	0.0	408.9
	9	27	9.2	0.0	412.2
	9	28	9.8	0.0	415.7
	9	29	11.4	0.0	419.5
	9	30	15.3	0.0	423.9



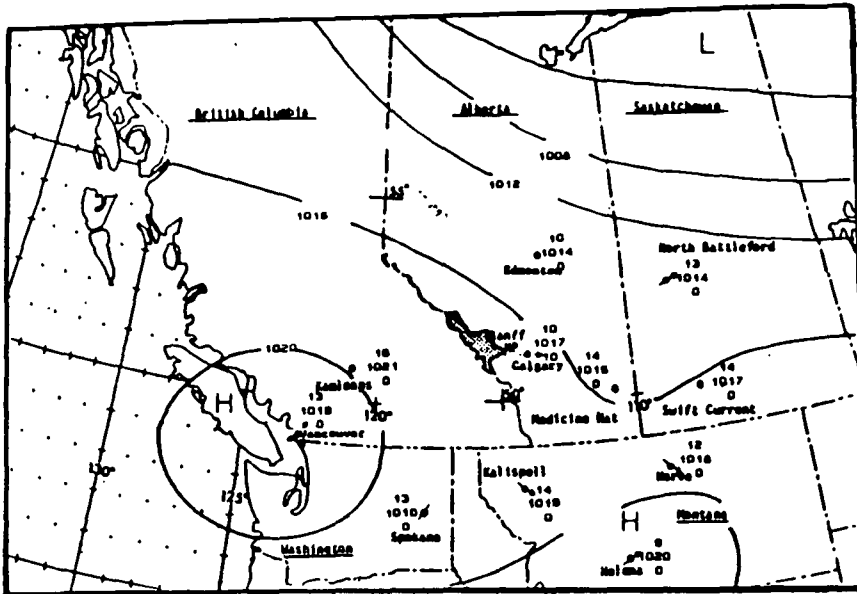
Map # 42: Surface Map:
May 8, 1908 - 8:00 p.m.



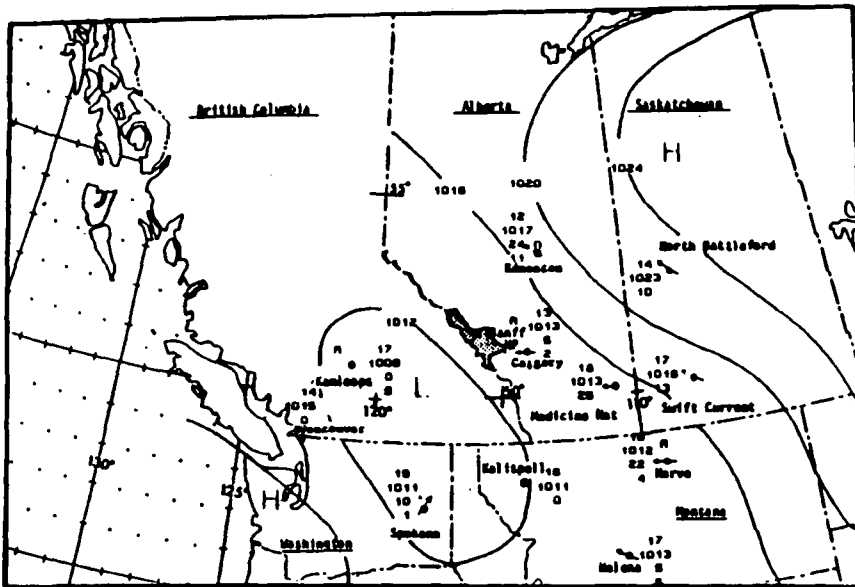
Map # 43: Surface Map:
June 26, 1908 - 8:00 p.m.



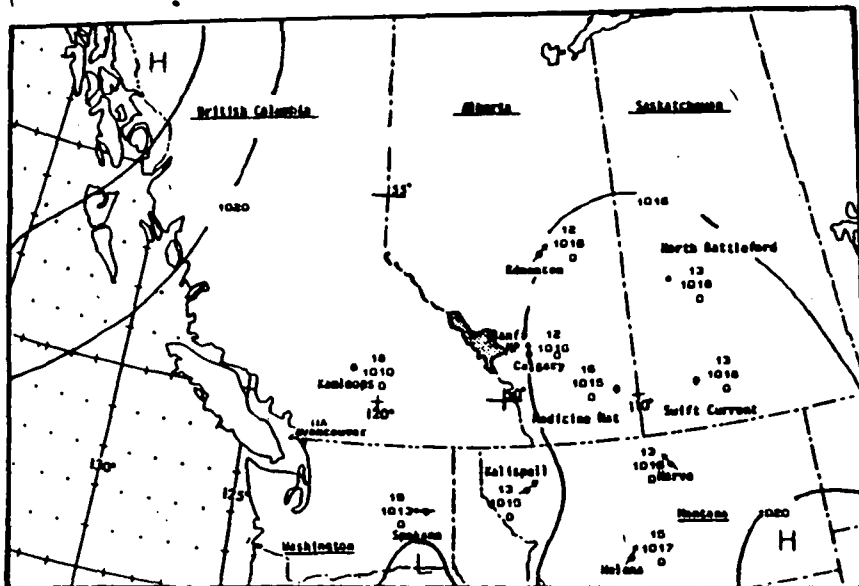
Map # 44: Surface Map:
July 1, 1908 - 8:00 p.m.



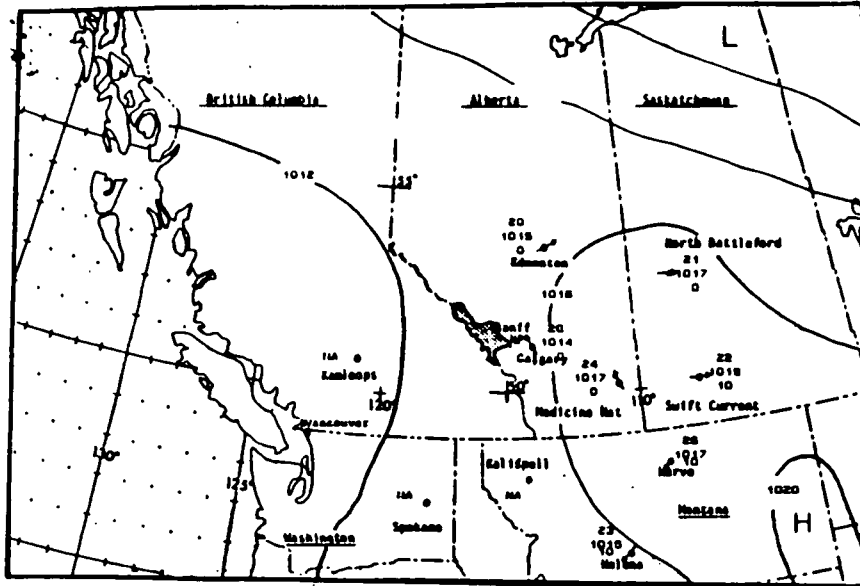
Map # 45: Surface Map:
July 7, 1908 - 8:00 p.m.



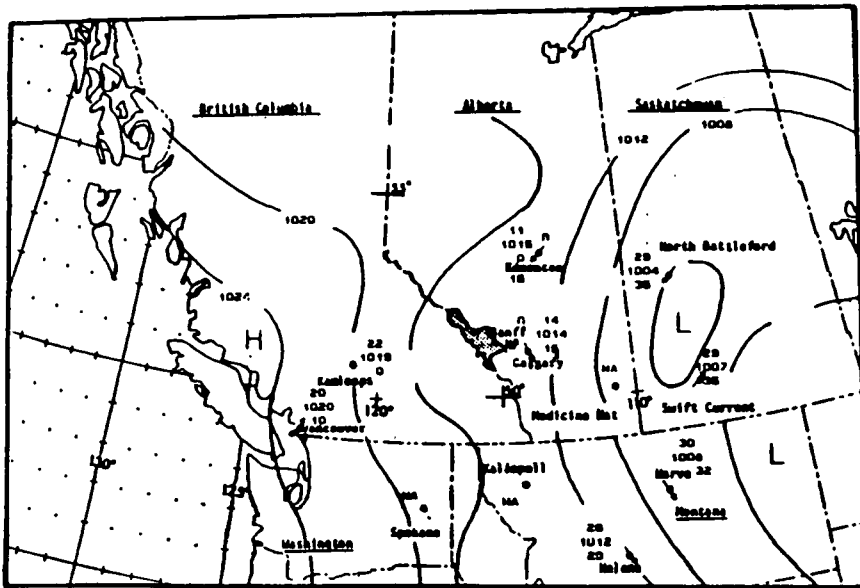
Map # 46: Surface Map:
July 14, 1908 - 8:00 p.m.



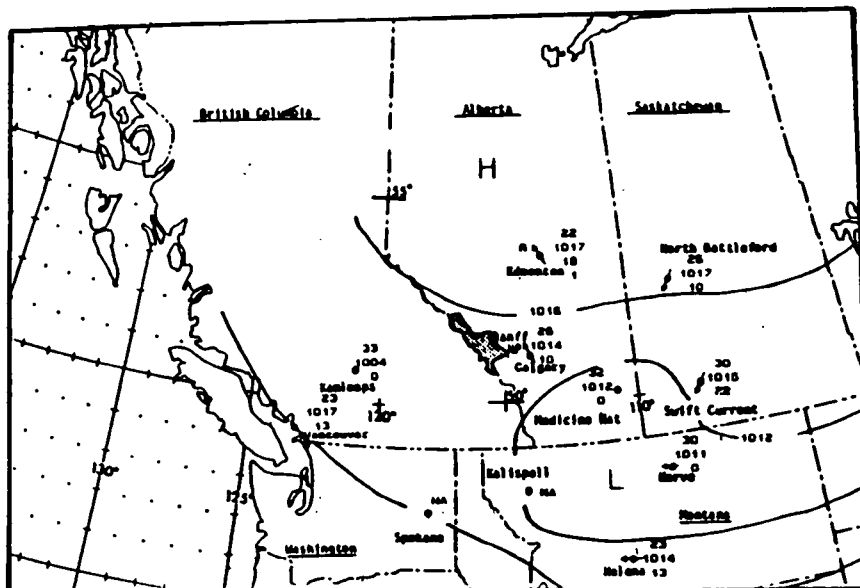
Map # 47: Surface Map:
July 21, 1908 - 8:00 p.m.



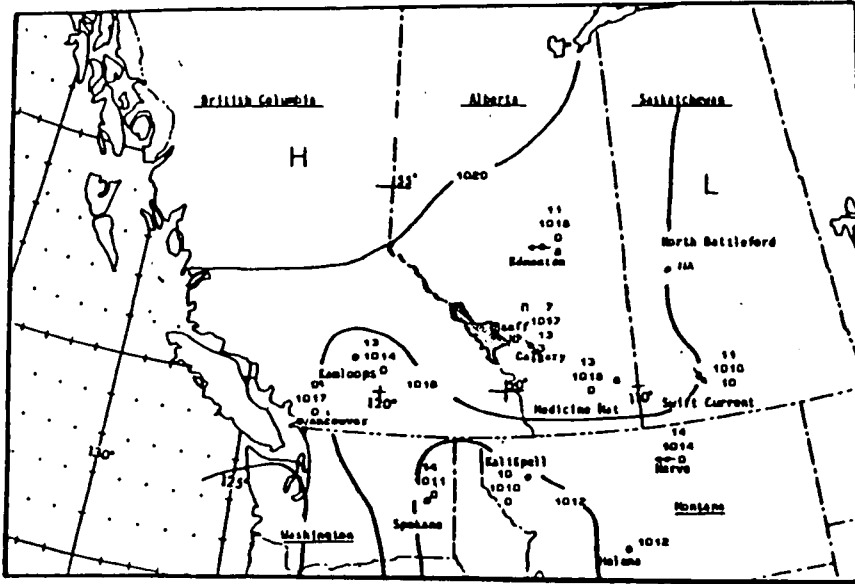
Map # 48: Surface Map:
July 26, 1908 - 8:00 p.m



Map # 49: Surface Map:
July 28, 1908 - 8:00 p.m



Map # 50: Surface Map:
July 31, 1908 - 8:00 p.m



Map # 54: Surface Map:
August 11, 1908 - 8:00 a.m.

May was a relatively cool month with the average daily high being 3.8°C below normal. This phenomenon along with excessive rain was probably the result of an upper trough persisting over Alberta throughout the month. As a result cyclonic disturbances passed over the Rockies frequently and had significant effect on the weather. Five major cyclonic disturbances passed over Alberta bringing precipitation to the Rockies. Map # 42, May 8, 1908, depicts the most significant disturbance which resulted in 25 mm. of precipitation being recorded in Banff. This low was squeezed or compressed between two strong high pressure systems and as a result intensified producing heavy precipitation. This system broke down on the 9th but its remnants amalgamated with another low over the Northwest Territories on the 10th and 11th. Subsequent to the new low formation, precipitation fell in Banff on the 10th, 11th, 12th and 13th. A low over Montana merged with a trough in the Northwest Territories on the 15th and the subsequent Alberta low brought precipitation on the 16th, 17th, 18th and 19th. The fourth disturbance resulted as a trough from the Northwest Territories extending into Alberta on the 23rd and deepening on the 24th and 25th and Banff received another 11 mm. of precipitation. A similar situation occurred on the 29th and another 10 mm. of rain fell in Banff on the 30th.

The first days of June were dominated by a persistence of low pressure. A trough from the 31st of May developed into a well defined low on the 1st of June and slowly moved south on the 2nd and 3rd as it weakened. Thirteen millimeters of precipitation fell on Banff on the 1st and a few millimeters fell on the 2nd, 3rd and 4th. Alberta lay under the eastern edge of a trough on the 8th and 9th and the resulting southerly flow brought temperatures to the high teens.

As the trough and its associated cold front passed over Banff on the 10th and 11th winds shifted to the northwest and 6.4 mm. of rain fell. By the 13th barometric pressure rose and on the 14th and 15th a southeast flow brought warm temperatures. Temperatures began to fall on the 16th as a low deepened east of the Rockies; by the 19th it had developed into an intense low over the prairies and as upslope

conditions persisted. Banff recorded rain. This system then went through a number of expansions and contractions on the 20th and 21st and another 14 mm. of rain fell in Banff. Finally as this system tracked east it was replaced by a ridge of high pressure and temperatures rose into the low 20's on the 24th and 25th. This ridge was then replaced by a trough on the 26th and 27th (Map # 43) and 20 mm. of rain fell as temperatures dipped to a low 5°C. The low tracked eastward as a high pushed inland over the United States coast. Temperatures remained cool throughout the month as the high remained south off the U.S. border and Alberta was under a northeasterly flow.

June had also been a cool month with average daily highs being 4°C cooler than the monthly average high temperatures. Persistence of troughs throughout the month may have again been the result of an upper trough allowing the passage and amplifying the effect of cyclonic disturbances. This would also explain the southerly track and lack of high pressure throughout the month.

As the high pressure system of the last days of June tracked east Alberta lay in its southerly flow (Map # '44) and temperatures reached a pleasant 23°C. Barometric pressures began to fall on the 2nd as a trough pushed into Alberta from the Northwest Territories. As the low intensified on the 3rd and 4th Banff was under a northerly flow and temperatures fell to 13°C. The low was relatively dry and negligible rain fall occurred. Temperatures again rose as a high pushed inland off the coast and skies cleared. By the 7th as southern Alberta was under the influence of high pressure (Map # 45) temperatures rose to 22°C. A trough from the Northwest Territories intruded over Alberta on the 9th and temperatures along with barometric pressures fell. A ridge of high pressure lay off the coast and as it tracked northward the low was forced northeastward. Temperatures rose and finally this high slipped over the northern reaches of the cordillera and southward over Alberta on the 11th (see Map # 46). Temperatures remained abnormally cool (17.0°C) under the southerly flow of this high as it lay directly over Alberta on the 13th. As a warmer low pressure system moved inland over the coast on the 14th meeting the cool air

of this high 5.3 mm. of rain fell in Banff (see Map # 46). This low continued to track northeast on the 15th and as Banff lay under a southerly flow from Montana temperatures reached 22⁰C. The British Columbia coastal low of the 14th moved inland as the low tracked northeast on the 15th and 16th. By the 18th the high now situated over British Columbia and Alberta brought increasingly warmer temperatures. This ridge temporarily receded as a Hudson Bay low forced its way into the prairies. As this low rapidly tracked east on the 20th the high again moved inland over the U.S. coast and by the 21st (Map # 47) was situated over the Saskatchewan-U.S. border. Temperatures soared to 28⁰C as Banff was under clear skies. This hot weather did not last long as a trough from Alaska and the Yukon intruded into Alberta on the 23rd. With falling temperatures came 4 mm. of rain. Temperatures continued to fall as this low intensified and remained quasi-stationary on the 25th. Winds were from the north as a coastal B.C. high pressure system tracked east.

This high tracked east over southern Alberta on the 26th (Map # 48), but temperatures remained cool. This was the first day of the Spray River Fire and as winds were from the southeast the fire burned toward Banff. This high was rapidly replaced by a low from the Northwest Territories on the 27th and by the 28th (Map # 49) as winds shifted to the northeast 7.4 mm. of rain fell in Banff. As temperatures dropped to a low 15⁰C and in conjunction with the rain the Spray River Fire died down. On the 29th a high pressure system moved inland over coastal B.C. replacing the low as it moved northeastward. By the morning of the 30th the high lay over the Dakotas and southern Saskatchewan, temperatures rose and the Spray River Fire was again burning but intensity remained moderate. Map # 50, July 31, illustrates the synoptic situation which brought temperatures as high as 26.4⁰C. A high over the northern prairies resulted in a westerly flow of hot dry air from southern Saskatchewan and temperatures warmed all over southern Alberta.

SYNOPTIC SITUATION IMMEDIATELY PRECEDING AND DURING THE CASTLE JUNCTION FIRE

On August 1 the low which lay over southeastern Alberta deepened and became a well defined cell over both Alberta and Saskatchewan. The resulting instability brought about 2.5 mm. of rain in Banff. A high over the British Columbia coast strengthened a northerly flow over Alberta and temperatures fell to 17⁰C on the 2nd. This situation remained quasi-stable on the 3rd, slowly tracking north-east. Throughout the 3rd and 4th barometric pressures and temperatures rose as a high moved inland from the coast. A weak high developed over southern Saskatchewan and the Dakotas on the 5th, and as winds came from the southeast temperatures rose to 24⁰C. A trough from the Northwest Territories began entering Alberta on the 5th and by the 6th had formed a weak low over B.C. and Alberta. As an east-southeast flow developed, temperatures although falling, remained warm. By the 7th this low had dissipated and been replaced by a weak high (Map # 51). Temperatures remained in the low 20's as .8 mm. of rain fell in Banff. Drought code values on the 7th were 376.6 which was 34 points below normal indicating that moisture in deep duff layers was approximately normal for this time of year. At about this time the Castle Junction Fire ignited. Although ignition source was believed to be campers the synoptic situation of the 7th may have produced a dry lightning strike. Local instability was most likely prevalent as the low was replaced by a high and could have produced lightning. Light rains were received in both Banff and Calgary as a result of this instability.

Winds were from the southeast on August 8 as the previous day's high tracked east and a more intense high lay over coastal B.C. On the evening of the 8th a trough from the Yukon began to invade northern Alberta and by the 9th (Map # 52) dominated Alberta, Saskatchewan and Montana weather. The following excerpt from the August 25 Crag and Canyon described fire behavior during the 9th:

"A fire which started near Castle Mountain last week, and which was nearly put out by Sunday morning, leaped all

barriers in the afternoon, and in 1½ hours had raced over eight miles of country."

The intrusion of this trough and its accompanying cold front had some obvious effects on fire behavior. As the low developed in Alberta during the early morning hours the cold front was indiscernible but probably lay west of Banff. Winds were probably from the southeast ahead of the front and relative humidity was low. As the front passed over the fire winds shifted to the southwest and west and were quite strong. Size and intensity of the fire were unknown before the frontal passage but under frontal conditions the fire blew up and moved as a running crown fire. Fire intensity at this time was extreme and in 1½ hours the fire burned in a east-northeast direction for 12.8 km.

The Spray River Fire also showed signs of increased activity on Sunday afternoon. The following excerpt from the August 15 Crag and Canyon revealed the situation:

"A number of guests at the CPR hotel got into a panic last Sunday, when dense clouds of smoke rose from Goat Mountain, due to the fire running up the slope of the mountain facing town. Several residents of Banff were also on edge, and have had to stand a good deal of "joshing" since, on account of their unreasoning fears."

The fire had been burning in a northerly direction. Under the influence of southerly winds, its intensity at this time appeared to have been low to moderate. With the passage of the front its intensity accelerated. Unfortunately no information regarding the fire behavior exists, however, the fire probably spread further up Mount Rundle and Goat Mountain as winds were predominantly from the southwest but were most likely variable. By the evening of the 9th as winds shifted to the west-northwest the fire blew back on itself and intensity diminished.

Unlike the Crag and Canyon, I believe worried guests and Banff residents had justified fears. Had winds continued from the south-southwest and the fire continued down the Spray Valley those doing the joshing might have changed their tune.

SYNOPTIC SITUATION AT THE END OF THE CASTLE JUNCTION FIRE
AND SPRAY RIVER FIRE

As the trough of the 9th tracked east frontal instability diminished and the Castle Junction Fire died down. Winds continued to shift to the west-northwest and by the evening were out of the north and weak. As the situation persisted the fire blew back on itself and little if any spread occurred as intensity continued to diminish. The Spray Valley Fire followed similar behavior patterns with intensity and rate of spread diminishing as winds shifted to the north-northwest. As winds remained from the north-northeast throughout the 10th neither fire spread appreciably. Map # 53 illustrates the synoptic situation in the evening of the 10th.

On the 11th (Map # 54) the synoptic situation had not changed significantly and as the high over northern B.C. and low in Saskatchewan promoted a northeasterly flow temperatures in Banff fell to 14°C. In conjunction with falling temperatures a low over Idaho and Montana promoted the east-northeasterly upslope flow and Banff recorded 9 mm. of rain. As temperatures remained cool on the 12th and 13th another 2 mm. of rain fell. This rain and accompanying low temperatures greatly reduced fire intensity and spread on both fires and mop-up began.

CUTHEAD CREEK FIRE - AUGUST 12-19, 1929

GENERAL DESCRIPTION

Virtually all of North America was subjected to drought conditions throughout July and August of 1929. Banff was no exception and as a result recorded a bad fire season. Although only one major fire occurred in 1929, it consumed 2900 ha. from August 12-19 and was known as the Cuthead Creek Fire.

This synoptic analysis will include interpretations of data from Lake Louise. This data will include temperature, rainfall and drought code values for summer seasons. Prior to 1915 Lake Louise had no weather recording station and since this is the first post-1915 analysis, it will include this information. It is hoped that the inclusion of this data will aid the overall accuracy of the analysis.

From all available information it appears that an upper ridge or omega blocking high persisted throughout the last two weeks of July and most of August. This theory would explain the greatly above normal temperatures and below normal precipitation for July and August. Unfortunately, this theory will never be proven due to the fact that it wasn't until 1940 that upper air measurements were conducted.

SYNOPTIC SITUATION IN MONTHS PRECEDING FIRE

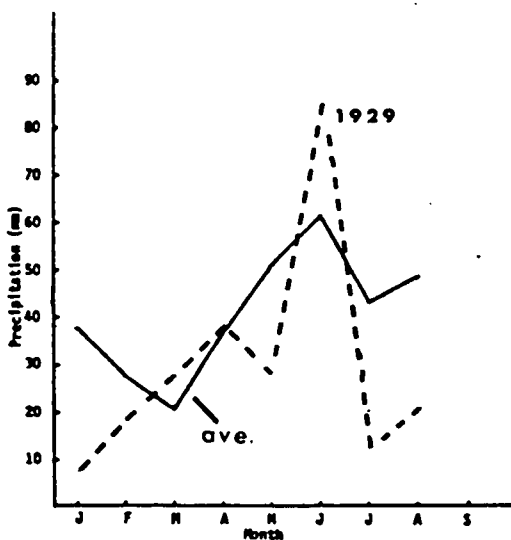
Table 7, Precipitation Trends, and Graph 5 illustrate precipitation trends throughout the winter, spring and summer of 1929. The winter of 1929 was a poor one for skiing with Banff receiving 44% of its normal December, January and February precipitation value. Although summer drought conditions were not a result of low winter precipitation they undoubtedly had a significant effect on the extreme dryness which occurred. The passage of March and April brought about an increase in precipitation to above average and average values. Although March precipitation was 38% above normal it had little effect on the

Table #7 - Monthly Precipitation - 1929

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
1929	.86	1.88	2.87	3.81	2.95	8.46	1.42	2.08	24.33
Average 1951-1980	3.82	2.78	2.09	3.76	5.18	6.13	4.24	4.89	33.89
% of Norm	22.5	67.6	138.0	1.01	56.9	13.8	33.4	42.7	71.8

December 1928 - 15.5mm = 40.9%

Graph #5 - Monthly Precipitation - 1929



 *****BANFF NATIONAL PARK DROUGHT CODE VALUES*****

CARRY-OVER VALUE: 247-dc

Station is Banff; Overwinter Mean = 179mm
 Year = 1929

4	1	-1.3	0.0	248.5
4	2	-0.2	0.0	249.4
4	3	0.3	0.0	250.4
4	4	-4.1	9.4	227.5
4	5	-2.6	1.3	227.9
4	6	-1.9	0.0	228.5
4	7	-3.0	0.0	229.0
4	8	-6.3	0.0	229.4
4	9	2.0	0.0	230.8
4	10	-0.3	0.0	231.6
4	11	0.9	0.0	232.7
4	12	2.6	0.0	234.1
4	13	2.6	0.3	235.5
4	14	6.4	0.0	237.6
4	15	5.3	0.8	239.5
4	16	4.2	0.3	241.2
4	17	2.0	2.3	242.6
4	18	6.4	0.0	244.7
4	19	9.2	0.0	247.3
4	20	5.3	0.0	249.2
4	21	8.7	1.0	251.7
4	22	4.8	10.2	227.8
4	23	4.2	1.8	229.5
4	24	10.9	0.0	232.4
4	25	15.3	0.0	236.1

overwinter precip. = 77.5

Spring Start-up Value = 232.4

4	26	13.7	0.0	235.8	
4	27	10.9	0.0	238.8	
4	28	10.9	0.0	241.7	
4	29	3.1	4.3	235.0	
4	30	6.4	6.6	222.5	
5	1	9.2	0.8	226.5	
5	2	10.3	0.3	230.8	
5	3	4.2	4.8	224.5	
5	4	-1.3	1.8	226.7	
5	5	2.6	0.0	229.6	
5	6	4.8	0.0	232.8	
5	7	5.3	0.0	236.2	
5	8	6.4	1.3	239.8	
5	9	7.0	0.3	243.4	
5	10	13.7	0.0	248.3	
5	11	12.0	0.0	252.9	
5	12	15.9	0.0	258.1	
5	13	3.1	8.4	240.2	
5	14	0.3	7.6	225.0	
5	15	10.3	0.0	229.3	
5	16	7.0	0.5	232.9	
1	5	17	10.3	0.3	237.2
5	18	13.7	0.0	242.1	
5	19	18.1	0.0	247.7	
5	20	18.7	0.0	253.5	
5	21	19.2	0.0	257.4	
5	22	22.6	0.0	265.8	
5	23	22.0	0.0	272.2	
5	24	14.2	1.3	277.1	
5	25	8.1	2.3	281.0	
5	26	11.4	0.0	285.5	
5	27	8.1	0.0	289.3	
5	28	12.6	0.0	294.0	
5	29	15.3	0.0	299.2	
5	30	16.4	0.0	304.5	
5	31	16.4	0.0	309.9	

6	1	11.4	8.1	292.7
6	2	6.4	6.2	168.6
6	3	6.4	9.7	153.3
6	4	12.0	0.0	158.9
6	5	18.1	0.0	165.6
6	6	20.9	0.0	172.7
6	7	20.3	0.0	179.8
6	8	19.2	0.5	186.6
6	9	17.6	0.0	193.2
6	10	14.2	6.4	186.5
6	11	13.7	4.1	185.7
6	12	17.0	0.3	192.2
6	13	14.2	2.3	198.1
6	14	14.8	0.5	204.2
6	15	13.7	0.5	210.1
6	16	16.4	0.5	216.4
6	17	13.7	0.0	222.3
6	18	10.3	0.0	227.6
6	19	10.3	0.0	232.8
6	20	11.4	0.0	238.3
6	21	12.0	0.0	243.8
6	22	12.6	0.0	249.5
6	23	13.7	0.0	255.4
6	24	20.3	0.0	262.4
6	25	17.6	5.3	257.3
6	26	13.7	0.0	263.2
6	27	17.0	0.0	269.6
6	28	15.9	0.3	275.9
6	29	19.2	0.0	282.8
6	30	18.7	0.0	289.5
7	1	24.2	0.0	297.6
7	2	22.6	0.0	305.4
7	3	18.7	0.0	312.4
7	4	14.8	0.3	318.8
7	5	14.2	0.0	325.1
7	6	11.4	7.4	309.8
7	7	15.3	2.0	316.2
7	8	19.8	0.0	323.5
7	9	19.2	2.5	330.7
7	10	12.0	0.3	336.5
7	11	12.0	0.0	342.4
7	12	18.1	0.0	349.3
7	13	25.3	0.0	357.6
7	14	25.3	0.0	365.9
7	15	22.6	0.0	373.6
7	16	22.6	0.0	381.4
7	17	24.8	0.0	389.6
7	18	27.6	0.0	398.2
7	19	27.0	0.0	406.8
7	20	17.6	1.3	413.7
7	21	18.1	0.0	420.6
7	22	20.9	0.0	428.1
7	23	22.6	0.0	435.9
7	24	25.3	0.0	444.1
7	25	24.2	0.9	452.2
7	26	15.3	0.0	458.7
7	27	20.3	0.0	466.0
7	28	25.3	0.0	474.3
7	29	27.0	0.0	482.8
7	30	28.1	0.0	491.6
8	1	22.0	0.0	500.4
8	2	14.8	0.0	507.3
8	3	19.2	1.5	513.0
8	4	18.7	1.8	519.5
8	5	17.6	0.0	525.8
8	6	23.1	0.0	532.0
8	7	24.2	0.0	539.2
8	8	17.6	5.8	546.5
8	9	21.4	1.0	552.2
8	10	22.0	0.0	558.1
8	11	24.2	0.0	564.4
8	12	25.7	0.0	570.7
8	13	25.9	0.0	576.4

8	14	24	2	0	569	.7
8	15	20	3	0	576	.4
8	16	20	3	0	583	.0
8	17	23	1	0	590	.2
8	18	22	0	0	597	.2
8	19	13	7	7	558	.8
8	20	11	4	0	563	.9
8	21	18	7	0	570	.2
8	22	20	3	0	576	.9
8	23	20	9	0	583	.7
8	24	17	6	1	589	.8
8	25	23	7	0	597	.1
8	26	19	2	0	603	.6
8	27	24	8	0	611	.0
8	28	29	2	1	619	.3
1						
8	29	26	4	0	627	.0
8	30	25	9	0	634	.7
9	1	22	6	0	641	.8
9	2	11	4	2	645	.5
9	3	4	2	3	643	.5
9	4	9	8	0	665	.9
9	5	9	4	2	669	.8
9	6	8	7	0	673	.3
9	7	4	8	4	676	.5
9	8	12	6	8	671	.1
9	9	11	4	2	664	.9
9	10	18	1	0	669	.8
9	11	18	1	0	674	.8
9	12	19	2	0	679	.9
9	13	22	0	0	685	.6
9	14	15	9	0	690	.2
9	15	19	8	0	695	.4
9	16	22	0	0	701	.1
9	17	18	7	0	606	.2
9	18	21	4	0	611	.7
9	19	17	0	0	616	.5
9	20	14	2	0	620	.8
9	21	6	4	0	623	.6
9	22	4	2	0	626	.1
9	23	3	7	4	607	.4
9	24	0	9	1	609	.2
9	25	0	9	1	611	.1
9	26	9	2	0	614	.5
9	27	7	6	0	617	.5
9	28	1	4	0	621	.3
9	29	14	8	0	625	.7
9	30	15	9	0	630	.2
10	1	15	9	0	633	.8
10	2	15	9	0	637	.3
10	3	10	9	0	640	.0
10	4	6	4	4	617	.8
10	5	6	4	8	595	.3
10	6	7	6	0	597	.4
10	7	9	2	0	599	.8
10	8	8	7	0	602	.0
10	9	8	1	2	604	.2
10	10	7	0	3	606	.2
10	11	8	1	0	608	.3
10	12	9	8	0	610	.8
10	13	14	2	0	614	.1
10	14	15	3	0	617	.5
10	15	15	9	0	621	.1
10	16	15	3	0	624	.5
10	17	7	0	2	626	.5
10	18	5	5	3	614	.6
10	19	6	4	0	616	.4

Table #9

 ***** BANFF NATIONAL PARK DROUGHT CODE VALUES *****

CARRY-OVER VALUE: 0-dc

400

Station is Lake Louise; Overwinter Mean = ~~400~~ mm
 Year = 1929

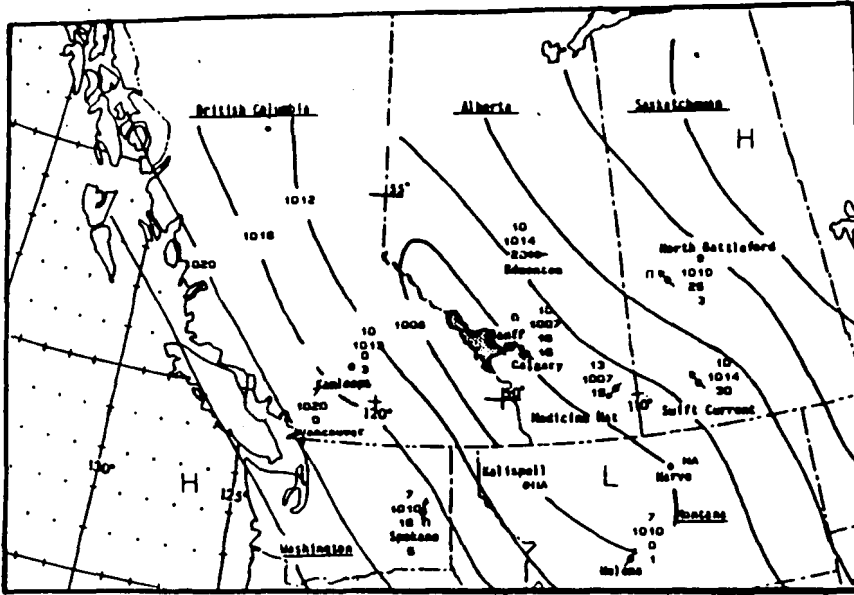
4	1	-3.0	0.0	0.4
4	2	-3.0	0.0	0.9
4	3	-3.0	0.0	1.3
4	4	-4.1	0.1	0.4
4	5	-6.3	0.1	0.4
4	6	-4.1	0.0	0.9
4	7	-4.1	0.0	1.3
4	8	-3.0	0.0	1.8
4	9	-0.8	0.0	2.6
4	10	-1.9	0.0	3.2
4	11	-0.8	0.0	4.0
4	12	0.3	0.0	5.0
4	13	1.4	0.0	6.2
4	14	3.1	0.7	7.6
4	15	2.0	0.3	8.8
4	16	2.0	0.3	11.1
4	17	0.3	0.0	15.1
4	18	3.7	0.0	16.8
4	19	7.0	0.0	19.0
4	20	4.2	0.0	20.7
4	21	4.8	0.3	22.5
4	22	4.2	0.3	24.2
4	23	3.1	0.0	25.7
4	24	9.2	0.0	18.3
4	25	11.4	0.0	21.3

overwinter precip.=164.9

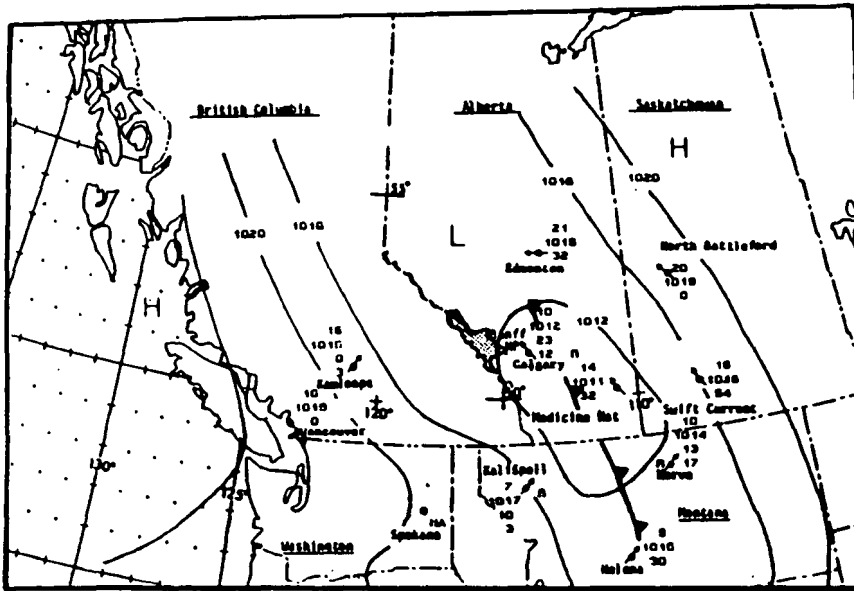
Spring Start-up Value= 69.9

4	26	10.9	0.0	72.8
4	27	8.7	0.0	75.3
4	28	8.7	0.0	77.8
4	29	8.1	0.0	80.2
4	30	8.1	0.0	82.7
5	1	8.1	0.0	86.5
5	2	7.0	0.0	90.2
5	3	3.7	0.7	80.4
5	4	2.6	0.2	83.3
5	5	2.6	0.2	86.2
5	6	5.9	0.0	89.6
5	7	5.9	0.2	93.1
5	8	5.9	0.3	96.6
5	9	5.9	0.1	100.5
5	10	1.0	0.0	105.1
5	11	9.8	0.0	109.3
5	12	15.9	0.0	114.5
5	13	9.8	0.6	105.7
5	14	7.0	0.5	109.4
5	15	8.7	0.8	113.3
5	16	5.9	3.8	111.9
5	17	9.8	0.0	116.1
5	18	14.2	0.0	121.0
5	19	17.0	0.0	126.5
5	20	16.4	0.0	131.9
5	21	17.6	0.0	137.4
5	22	21.4	0.0	143.7
5	23	20.3	0.0	149.7
5	24	13.7	0.4	146.9
5	25	7.6	0.8	150.7
5	26	6.4	0.0	154.2
5	27	6.4	0.0	157.8
5	28	10.9	0.0	162.2
5	29	17.0	0.0	167.6

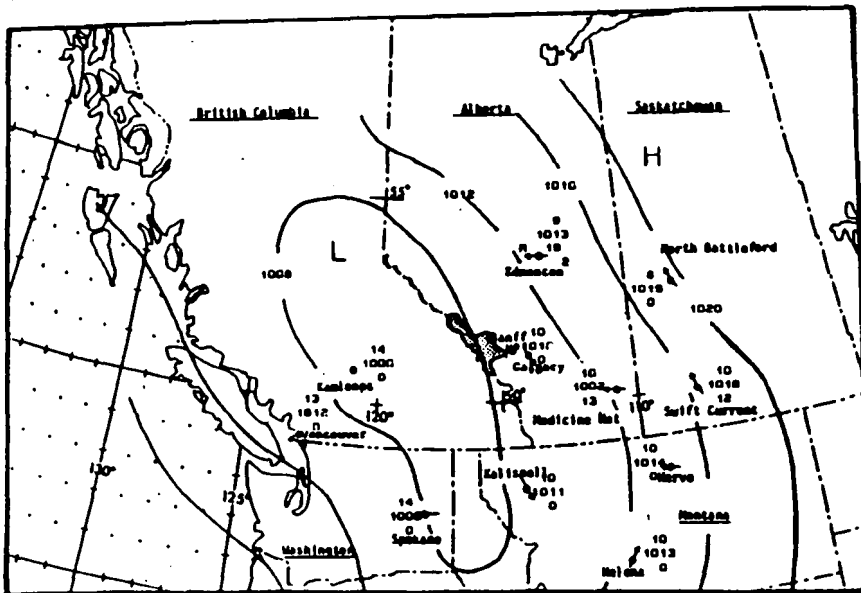
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08	14	20	9	00	491.2
08	15	19	8	00	497.7
08	16	16	4	00	503.7
08	17	10	0	00	509.5
08	20	8	1	00	500.5
08	21	17	0	00	511.2
08	22	18	7	00	517.6
08	23	19	2	10	524.1
08	24	14	2	00	529.6
08	25	19	2	00	536.1
08	26	18	1	10	542.3
08	27	23	7	00	549.6
08	28	27	6	00	557.6
1	29	24	2	00	564.9
08	30	24	2	00	572.3
08	11	20	9	00	579.1
08	12	13	1	10	583.1
08	13	19	9	10	529.2
08	14	14	2	90	532.6
08	15	16	5	00	536.0
08	16	19	2	20	539.3
08	17	19	2	20	542.7
08	18	18	7	00	512.7
08	19	14	4	60	516.5
08	20	13	1	30	520.5
08	21	17	1	10	524.9
08	22	19	2	00	529.7
08	23	14	2	00	534.8
08	24	16	4	00	544.1
08	25	19	4	00	548.7
08	26	19	2	00	553.9
08	27	18	7	00	559.2
08	28	14	8	00	564.2
08	29	13	1	80	568.6
08	30	12	6	00	572.7
08	13	13	7	00	574.9
08	14	10	2	10	471.2
08	15	10	2	30	473.7
08	16	10	0	00	475.7
08	17	10	0	00	446.5
08	18	10	0	00	449.4
08	19	10	0	00	452.7
08	20	12	2	00	456.1
08	21	13	6	00	460.0
08	22	13	7	00	464.2



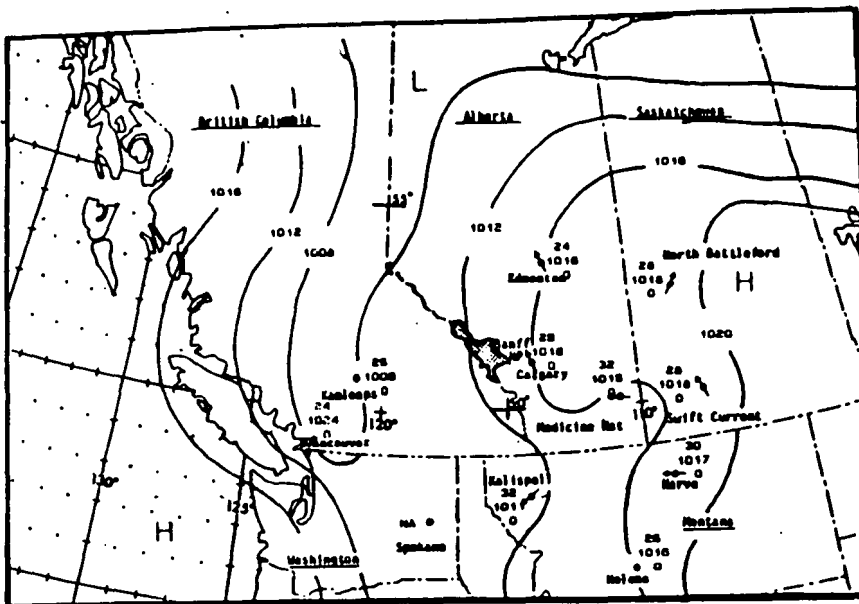
Map # 55: Surface Map:
June 2, 1929 - 8:00 a.m.



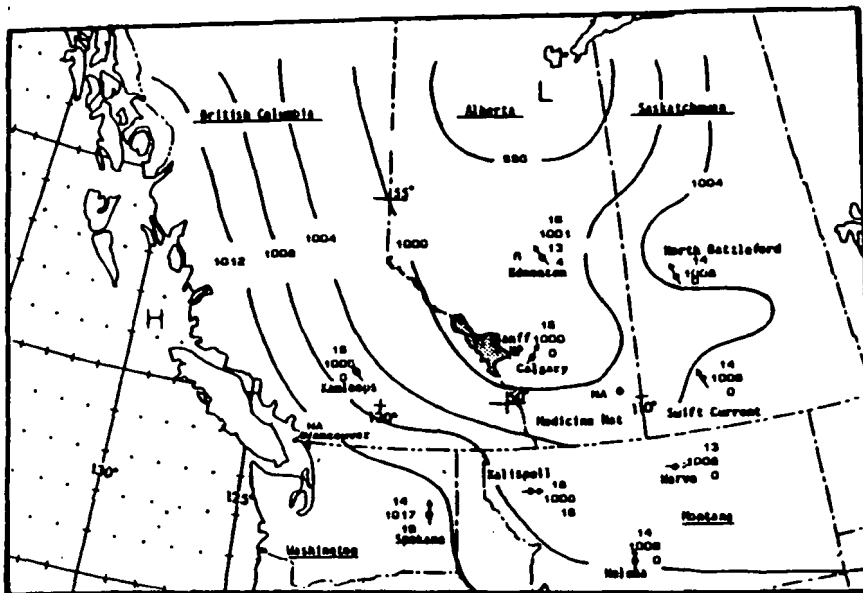
Map # 56: Surface Map:
June 2, 1929 - 8:00 p.m.



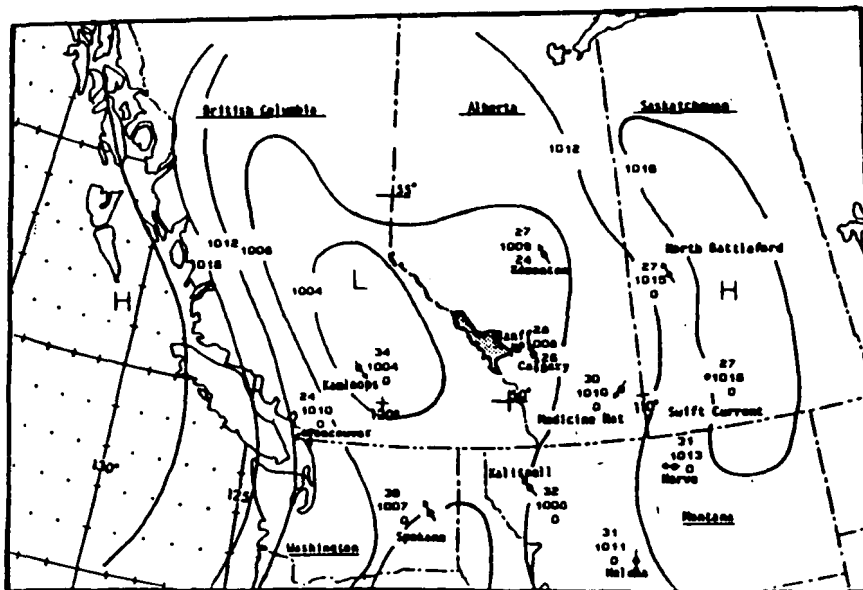
Map # 57: Surface Map:
June 25, 1929 - 8:00 a.m.



Map # 58: Surface Map:
July 13, 1929 - 8:00 p.m.

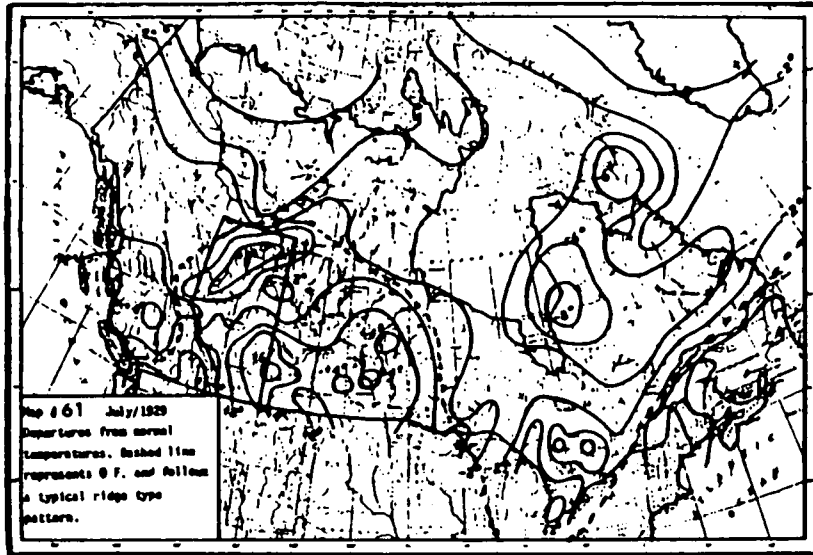


Map # 59: Surface Map:
July 20, 1929 - 8:00 a.m.

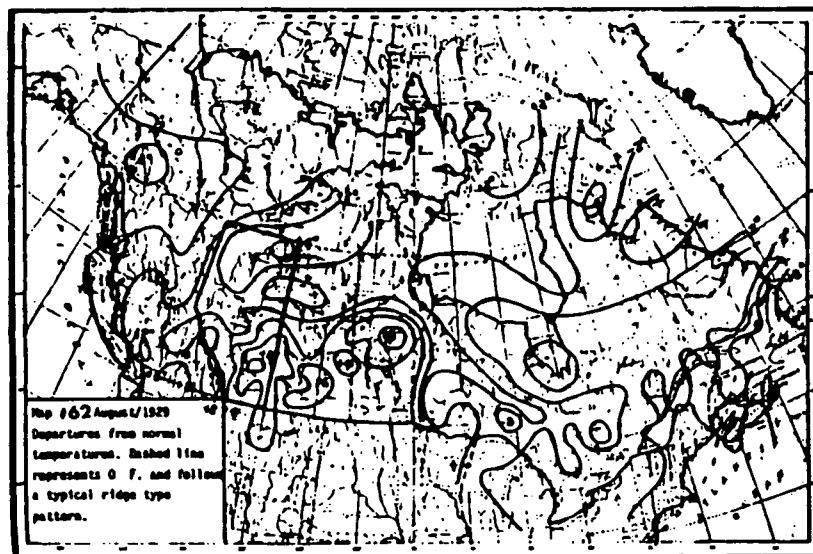


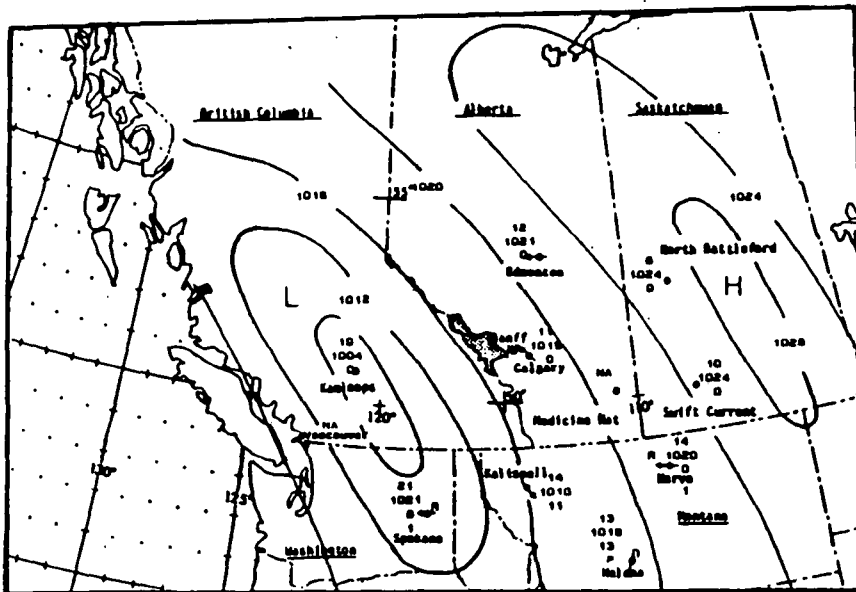
Map # 60: Surface Map:
July 30, 1929 - 8:00 p.m.

Map # 61: July, 1929: Departures from Normal Temperatures

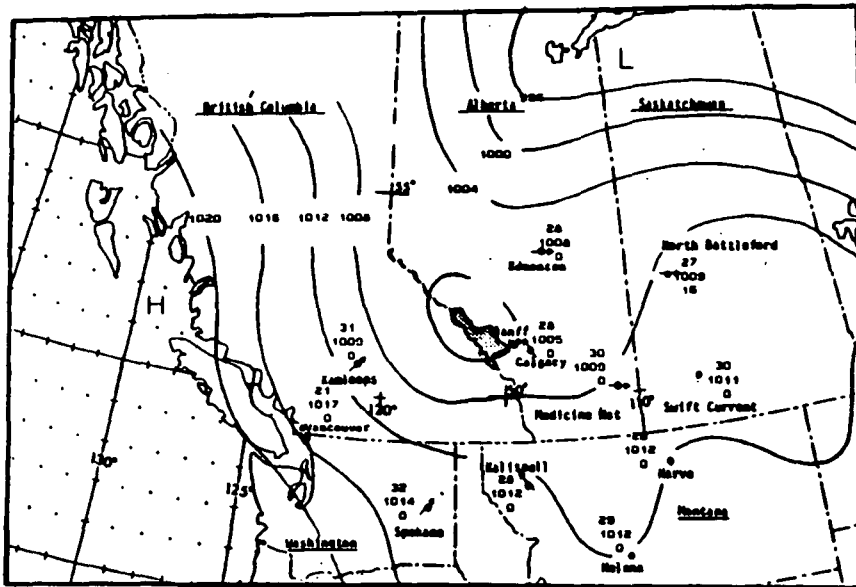


Map # 62: August, 1929: Departures from Normal Temperatures

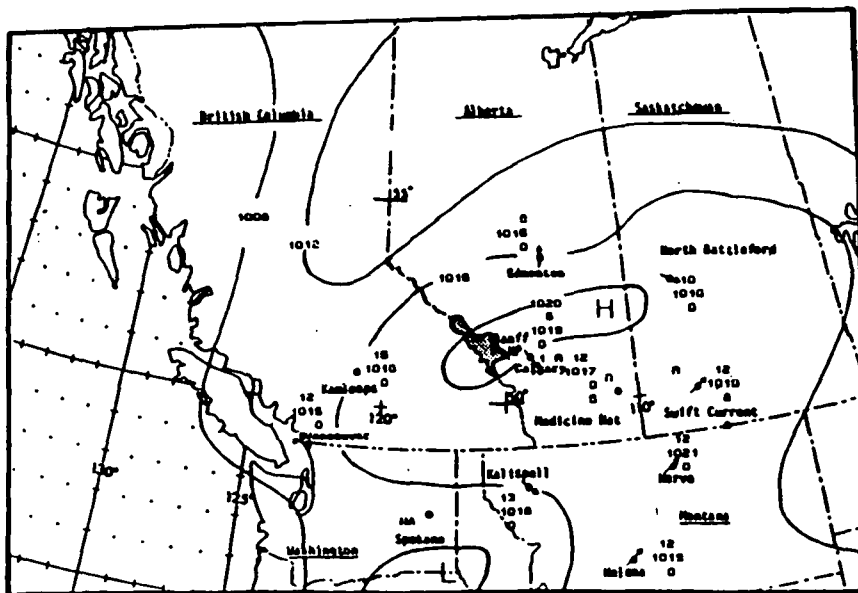




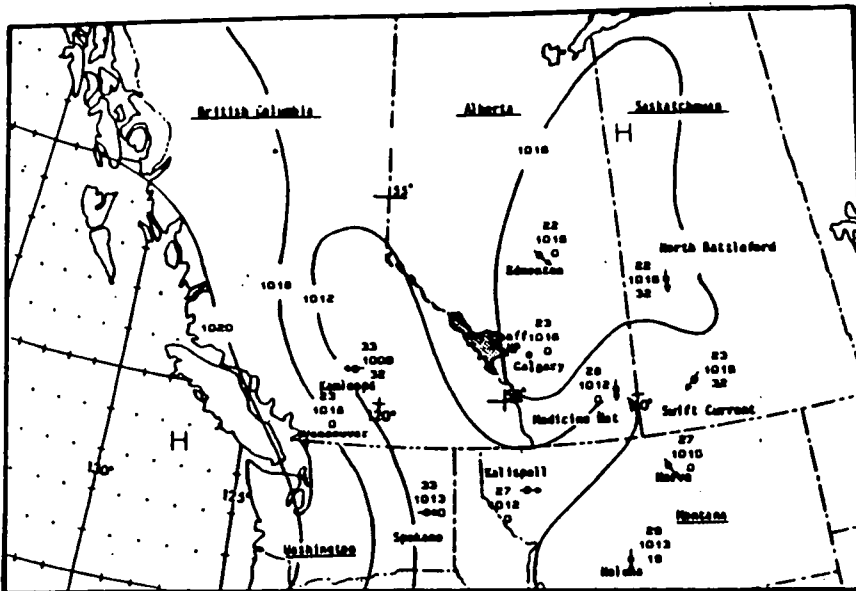
Map # 63: Surface Map:
August 3, 1929 - 8:00 a.m.



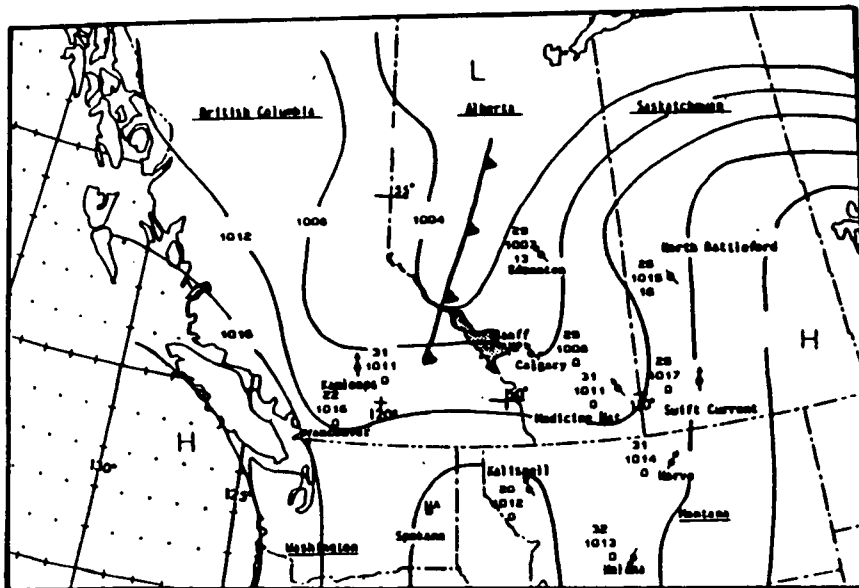
Map # 64: Surface Map:
August 7, 1929 - 8:00 a.m.



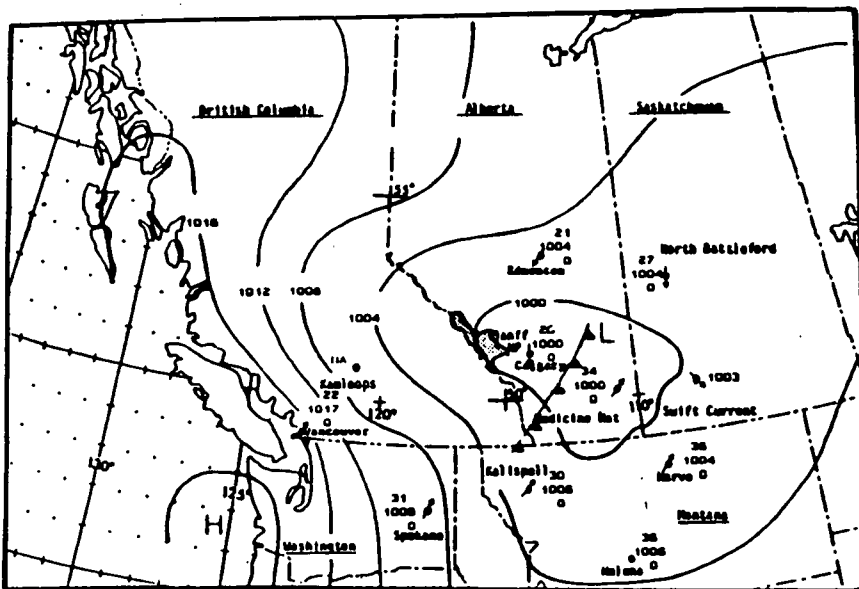
Map # 65: Surface Map:
August 11, 1929 - 8:00 a.m.



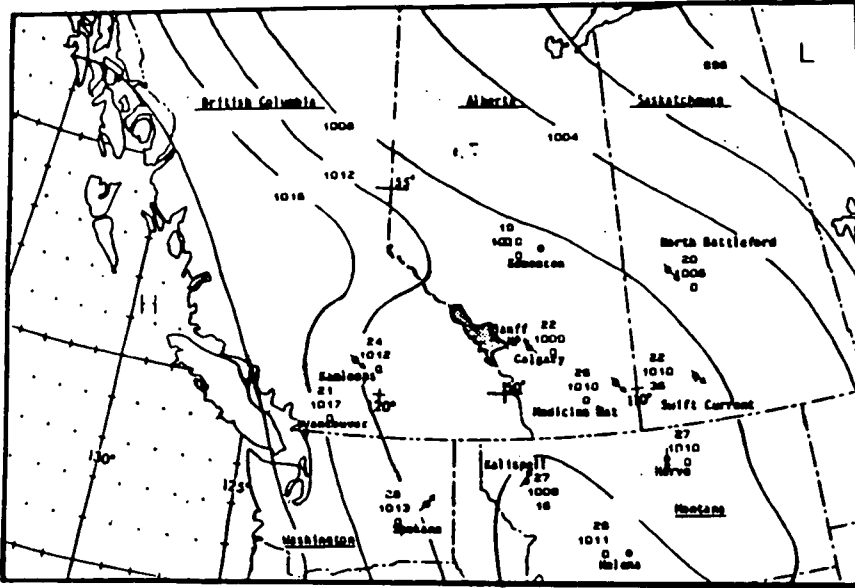
Map # 66: Surface Map:
August 12, 1929 - 8:00 a.m.



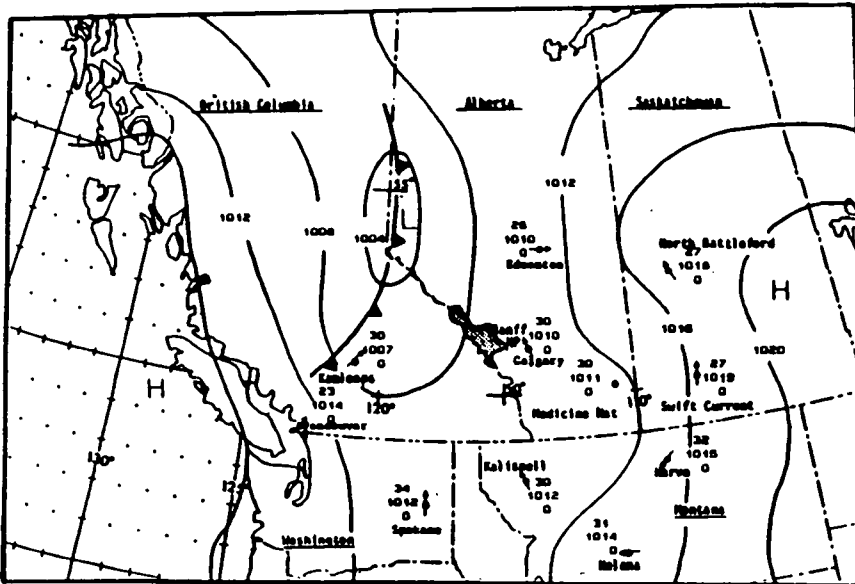
Map # 67: Surface Map:
August 13, 1929 - 8:00 p.m.



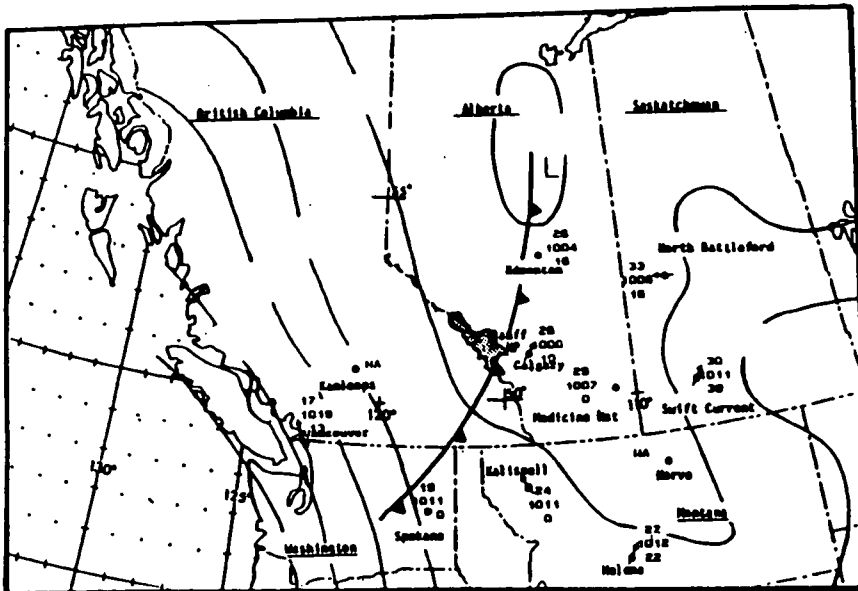
Map # 68: Surface Map:
August 14, 1929 - 8:00 p.m.



Map # 69: Surface Map:
August 15, 1929 - 8:00 p.m.



Map # 70: Surface Map:
August 17, 1929 - 8:00 p.m.



Map # 71: Surface Map:
August 18, 1929 - 8:00 p.m.

moisture content in deep duff layers, and the spring drought code start up value was 177 points above the norm of 55.4. This extreme value was the first sign that an extreme fire season might occur. As May ended with only 57% of its normal precipitation, moisture deficits increased and the drought code was 156 points above normal. Luckily no fires started in May of 1929. Had there been ignition of fires between May 18-22 large portions of the montane might have burned as a result of severe drying and warm temperatures.

As the summer months began a badly needed rainstorm occurred which dropped drought code values significantly. In total, 64.1 mm. of precipitation was recorded in Banff during June 1, 2 and 3. At Lake Louise this storm dropped only 23.9 mm. of precipitation, indicating that although the storm had widespread effects, intensity varied from place to place. It should be noted that winter precipitation at Lake Louise was near normal and the spring start up drought code had an average value of 69.9. The intensity of this three day storm was greatest on June 2nd when 76.2 mm. and 20.6 mm. of precipitation was recorded in Banff and Lake Louise respectively. Maps #55 and # 56 June 2, 1929, illustrates the synoptic situation which brought 76% of June's moisture.

As low pressure systems pass over the Rockies they often break up or weaken, reform and deepen over the prairies. On June 1-3 the low pressure system which brought severe rainstorms remained well defined as it passed eastward over the Rockies. On both sides of the low were strong high pressure systems lying parallel to the low. The gradient flow around each of these systems amplified wind speeds on both sides of the low and the squeezing effect intensified the instability and cold front. Maximum rainfall intensity most likely occurred immediately after the cold front passage which had a temperature gradient across the front of 10-11°C.

The precipitation received from this disturbance almost broke the 86 year 24/hr. June precipitation record and reduced drought code values by 140 points to 153.3 which was 1.4 points below normal. Had this

disturbance with its associated precipitation not occurred the 1929 fire season would have most likely been much worse.

The remainder of June was cool with daily temperatures exceeding average daily highs on only seven days. The Banff area was predominantly influenced by low pressure systems from June 9-22 and temperatures rarely rose higher than 15°C. Precipitation fell in Banff frequently during this time, but intensities were minimal with the greatest precipitation 10.5mm. falling on the 10th and 11th. On June 23, barometric pressure began to rise and by the 24th, Banff was under the influence of a high pressure system which brought south winds and warm temperatures. A low pressure system off the British Columbia coast moved inland on the 25th, Map # 57, and temperatures fell along with 5.3 mm. of rain. Barometric pressures rose on the 29th and the weather was clear and warm on the 30th.

July began with a brief period of warm weather with Banff being influenced by southerly flows, clear days and warm temperatures. As the high pressure system tracked east a trough extended into Alberta on the 2nd and temperatures moderated for the next 10 days. As the low pressure dominated precipitation fell on the 6th, 7th and 9th. Barometric pressure rose on the 12th and by the 13th southern Alberta was under the predominant influence of a southerly flow and temperatures reached 25°C plus. Map #58, July 13, illustrates a synoptic situation which promoted a southerly flow of warm dry air into Alberta from the mid-western States. This high pressure system was quickly replaced by a trough on the 15th and temperatures moderated until the 18th when pressure rose as Alberta weather was dominated by a high pressure system. Map # 59, July 20th, illustrates a low pressure system which dropped temperatures and 1.3 mm. of rain fell in Banff. As barometric pressures rose over southern Alberta so did the temperatures until the 26th when a trough over Saskatchewan and high over B.C. resulted in a northerly flow and falling temperatures.

The British Columbia high of the 26th tracked east and temperatures climbed into the high 20's by the 29th. Map #60, July 30, 1929,

depicts a southerly flow of warm dry air as the high over Saskatchewan and low over British Columbia tracked east.

As July came to an end, precipitation had been recorded on only six days (normal 12) and, in total, 33% of the normal July precipitation had fallen. This, in combination with temperatures that exceeded the average daily high for 15 days and the average daily maximum being 1.66°C above normal resulted in drought code values being 489 on July 30.

This drought code was 100 points above normal and the fire season looked to be a serious one.

July had been a hot dry month throughout western North America. The United States Weather Bureau reported that temperatures had been in excess of normal by $2-4^{\circ}\text{F}$ throughout the western States and that a precipitation deficit had occurred throughout the mid-west. Looking at Map # 61 Departures From Mean Temperature, July, indicated an extensive intrusion of warm weather over Alberta (dotted line). This surface temperature gradient was exactly the sort of pattern that would occur under an "Omega Blocking High". Although this theory is impossible to prove due to a total lack of information regarding upper air characteristics, it does explain low precipitation and high temperatures for July, 1929. Map # 60, also shows the occurrence of a deep low as designated by the subnormal temperatures over Ontario and Quebec.

SYNOPTIC SITUATION IMMEDIATELY PRECEDING AND DURING FIRE

On August 1st the British Columbia low pressure system of the previous day tracked east over Alberta and temperatures fell. A high pressure system over Alaska tracked southeast over Alberta on the second and temperatures were in the mid-teens. By the third (Map # 63) temperatures were rising as clear skies predominated under the high, and dry winds

came from the southeast. A low cyclonic disturbance moved inland over the British Columbia coast and as it passed over Banff, forcing the high east, 1.5 mm. of precipitation was recorded. This disturbance, situated over Alberta on the 4th brought another 1.8 mm. of precipitation and temperatures fell slightly. As this disturbance tracked south-southeast on the 5th and a high pressure system replaced it in Alberta Banff temperatures dropped to 17⁰C as winds came out of the north. Temperatures increased to 23⁰C on the 6th as Banff lay under clear skies and high barometric pressures.

Temperatures increased into the mid-twenties on the 7th as the high of the previous day tracked southeast and by the evening a trough extended into Alberta from the northern prairie provinces (see Map # 64). The trough of the 7th developed into a weak low pressure system on the 8th which was situated over south eastern Alberta. Winds were from the northwest and as temperatures fell to 17.6⁰C, so did 5.8 mm. of rain. As this system tracked east on the 8th another 1.0 mm. of rain fell.

As seen on the August 7th map, a high pressure system lay off the coast of British Columbia. This high pressure system began moving inland on the 9th and as it began to dominate Alberta's weather, temperatures rose. Temperatures were in the low and mid-twenties throughout the 10th and 11th as high pressure prevailed over Alberta. Map # 65 , August 11th, illustrates this situation. By the evening of the 11th this weak high had completely dissipated and was replaced by a weak low pressure system.

The Cuthead Creek Fire began on August 12th and the ignition source was believed to have been recreationalists (White - 1982). Drought codes had risen to 544.7 or 132.7 points above normal on the 12th. Low precipitation and high temperatures were responsible for such an extreme value. Map # 66 , August 12th, illustrates the synoptic situation as of the evening of the 12th. Temperatures were warm, 23.7⁰C in Banff, and winds were most likely variable as the weak high over Alberta and weak low over British Columbia fought for supremacy. The high pressure system intensified through the evening and began tracking southeast as a well developed trough extended into British

Columbia from the Northwest Territories. Map # 67 , August 13, depicts this trough and winds were probably from the south throughout the day as temperatures rose to 26⁰C. The cold front associated with this trough appeared to have had little effect on fire behavior as a result of a weak temperature gradient on its most southern extent. This trough then evolved to become well developed with a cold front which appeared to remain north of Banff (Map # 68). Gradient flow was from the north and temperatures fell slightly. The high pressure system off the coast, as shown in Map # 69 , pushed inland on the 15th and the cyclonic system of the 13th and 14th tracked northeast. Gradient flow remained from the north-northeast and temperatures fell to 20⁰C. As the high continued to move inland, Alberta's weather was influenced by a weak high on the 16th and temperatures rose slightly. Winds were most likely variable but gradient flow suggests south to westerly winds. This high intensified east of the Rockies on the 17th as a trough extended through northern Alberta and British Columbia (see Map # 70). Temperatures increased as a predominantly south gradient flow occurred.

SYNOPTIC SITUATION AT THE END OF THE FIRE

As the trough and accompanying cold front swept east on the 17th, 18th and 19th temperatures began to fall. Map # 71 illustrates the trough's position on the evening of the 18th and 5.3 mm. of precipitation fell in Lake Louise. From available information it appears that the cold front passed through Lake Louise late in the day and did not reach Banff until the 19th when 7.9 mm. of rain fell and temperatures dropped to a low 13.7⁰C. Banff was under a northwesterly flow and the Cuthead Fire made no major advances and was contained and extinguished promptly.

Throughout the rest of August temperatures remained warm and little rain fell. As the month came to a close 17 days recorded temperatures which exceeded the daily high and the average maximum temperature was 1.85⁰C above normal. Also in total, Banff received 42.7% of its normal

precipitation. As mentioned previously for the month of July, an upper ridge was most likely the cause of significantly below normal precipitation and above normal temperatures in August.

This temperature and rainfall abnormality was not a local phenomenon, and most of western North America reported a similar situation. The August 1929 Monthly Weather Review states that drought conditions persisted throughout the U.S. in August and caused a marked deterioration in crop growth over considerable areas. The review goes on to say that the weather in the far northwest was very warm with daily temperatures averaging normal or above normal nearly every day, and that some States had monthly State means that were the highest on record. Temperatures in the northern Rocky Mountain States were 4-7⁰F above normal. P.C. Day (1929) states in the review that "August 1929, was notable mainly for the wide extent and persistence of drought conditions". All these factors indicate the occurrence of an upper ridge. Day (1929) also states that "average pressure for the month, reduced to mean sea level, was comparatively high and above normal in all regions of the United States and Canada". Pressure distribution throughout August was unfavourable for the development of active cyclones, and, as in July, these storms were infrequent and maintained their identity as such for only short periods (Day, 1929). All of this information leads to only one possible conclusion. An Upper Omega Blocking High was responsible for extreme drought, abnormally high temperatures and a resulting bad fire season. Map #62 depicts the approximate boundaries of the ridge (dashed line 0⁰F line). Any area within this ridge was undoubtedly hot and drying during August 1929.

SILVERHORNE AND FLINTS PARK FIRES JUNE 25-28 and AUGUST 6-14 1936

General Description

Banff National Park's fire season of 1936 was one of the worst on record. Over 8000 ha burned that summer, and 73% of the burning occurred during a two week period in August. The Flints Park Fire consumed 5200 ha from August 6 - 14. The Howse Pass Fire, starting in B.C., burned northeastward into the Park and consumed 650 ha of forest within park boundaries. The Silverhorne fire of June 25, 1936, burned 1100 ha, and will briefly be discussed in this analysis.

The severity of the 1936 fire season was largely a result of a decimating drought which occurred throughout the entire year. This drought occurred on a very large scale with most of North America being affected, typifying the phrase "the dirty thirties". The persistence of high pressure over the central States and Canada brought about the severe drought, and several scientists have proposed theories as to why these climatological factors occurred. Some of these theories will be briefly discussed within this analysis and related to the situation in Banff National Park.

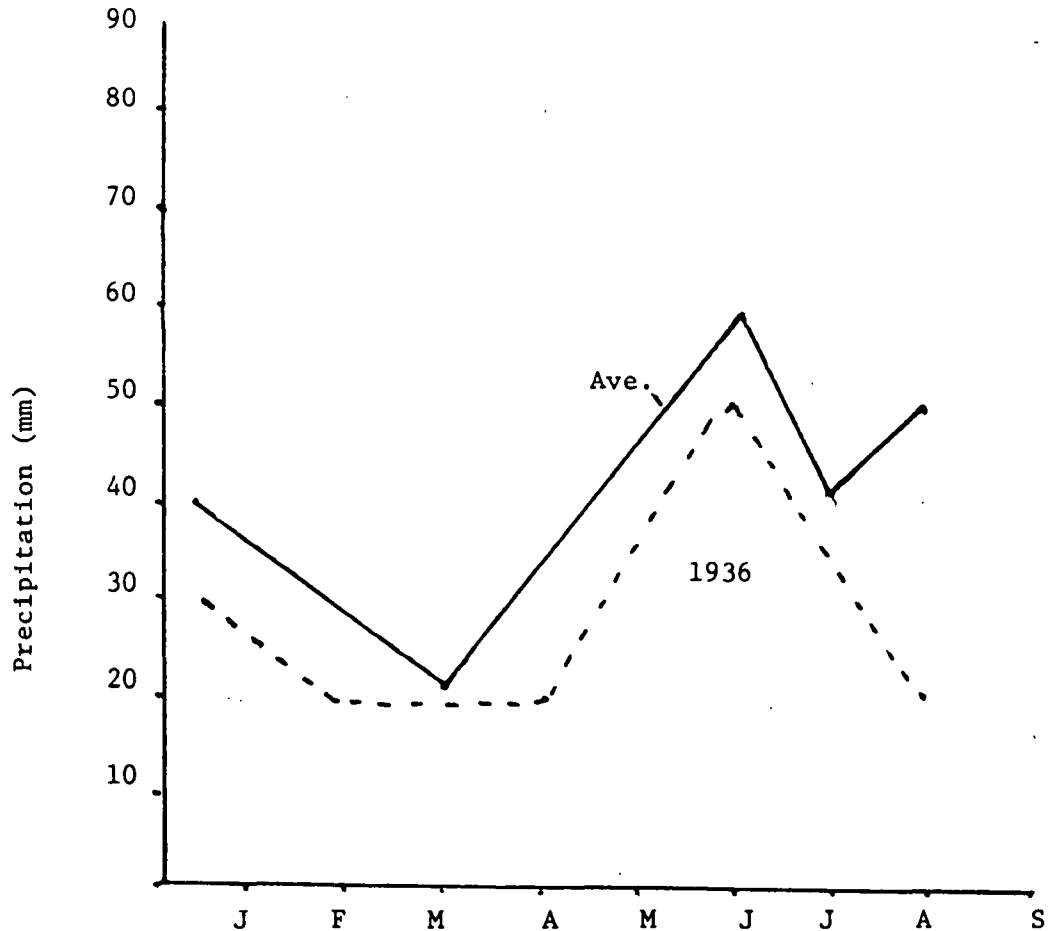
Synoptic Situation in Months Preceding Fires

Throughout the winter of 1935/36, precipitation was significantly below normal. As seen in Table 10 and Graph 6, January and February precipitation values were 79% and 67% below normal. This, in conjunction with December, 1935, precipitation being 30% of the normal brought about an overall winter precipitation 58.7% of the normal. As spring came to the Rockies, the moisture deficit continued. Although March precipitation was 89% of the normal, April rainfall was 49% of the normal. The spring start-up drought-code was 420.7 - 365.4 points above normal. As May began, it was clearly evident that severe drought already persisted in deep duff layers and that unless monsoon rains occurred soon, Banff Park wardens would learn a lot about fire suppression in the oncoming season.

Table # 10: Banff Monthly Precipitation, 1936

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Total</u>
1936	3.02	1.88	1.85	1.83	0.78	4.65	2.90	1.65	21.56
Average	3.82	2.78	2.09	3.76	51.8	6.13	4.24	4.84	32.18
% of Norm	79.0	67.6	88.5	48.7	43.7	75.0	68.4	33.7	67.0
			<u>Avg.</u>	<u>% Avg.</u>					
	Nov/35	.69	3.79	18.2					
	Dec/35	1.14	3.79	30.0					

Graph #6 Precipitation Trends 1936



*****BANFF NATIONAL PARK DROUGHT CODE VALUES*****

Table 11:

CARRY-OVER VALUE: 404-dc

Station is Anthracite; Overwinter Mean = 162mm
Year = 1936

4	1	-8.6	0.0	404.9
4	2	-5.2	0.0	405.4
4	3	-4.7	0.0	405.8
4	4	-3.6	0.0	406.3
4	5	2.0	0.0	407.6
4	6	3.7	0.0	409.2
4	7	4.2	0.0	410.9
4	8	4.8	0.0	412.8
4	9	5.9	0.0	414.8
4	10	5.9	0.0	416.8
4	11	7.0	1.3	419.0
4	12	9.8	0.0	421.7
4	13	10.3	0.0	424.5

overwinter-precip. = 20.1

Spring Start-up Value = 420.7

4	14	9.8	0.0	423.4
4	15	12.6	0.0	426.7
4	16	18.7	0.0	431.0
4	17	20.9	0.0	435.7
4	18	23.7	0.0	440.9
4	19	17.0	0.0	444.9
4	20	8.7	0.0	447.5
4	21	14.2	0.0	451.0
4	22	11.4	5.3	435.4
4	23	5.9	0.0	437.4
4	24	2.6	2.8	438.8
4	25	12.0	0.0	441.9
4	26	9.8	0.0	444.7
4	27	6.4	8.9	411.7
4	28	8.7	0.0	414.3
4	29	15.3	0.0	418.0
4	30	15.9	0.0	421.8
5	1	14.8	0.0	426.9
5	2	13.7	0.0	431.7
5	3	15.9	0.0	437.0
5	4	18.1	9.9	403.8
5	5	10.9	0.0	408.2
5	6	12.6	0.0	412.9
5	7	14.8	0.0	417.9
5	8	13.1	0.0	422.7
5	9	15.9	0.0	428.0
5	10	14.2	9.4	397.1
5	11	7.6	3.9	394.4
5	12	14.8	0.0	399.5
5	13	22.6	0.0	406.0
5	14	24.8	0.0	412.8
5	15	19.2	0.5	418.7
5	16	12.0	0.0	423.3
5	17	13.1	0.0	428.0
5	18	17.6	0.0	433.6
5	19	18.1	0.0	439.3
5	20	9.8	4.3	430.1
5	21	10.3	0.0	434.3
5	22	10.9	0.0	438.7
5	23	15.9	0.0	444.0
5	24	17.6	0.0	449.5
5	25	20.9	0.0	455.7
5	26	24.8	0.0	462.6
5	27	17.6	0.0	470.6
6	1	18.1	0.0	477.0
6	2	10.3	0.0	417.3

6	3	12	6	0	0	423	0
6	4	18	1	0	0	429	6
6	5	17	6	5	0	418	6
6	6	4	2	0	0	422	7
6	7	2	6	4	0	414	7
6	8	9	8	0	0	419	9
6	9	14	8	0	0	425	9
6	10	17	6	0	0	432	5
6	11	17	0	3	6	429	1
6	12	15	9	3	0	428	4
6	13	18	7	0	0	435	2
6	14	17	6	1	3	441	8
6	15	17	6	0	0	448	3
6	16	15	9	3	6	444	4
6	17	12	0	0	0	449	9
6	18	17	0	0	0	456	4
6	19	20	9	0	0	463	6
6	20	22	6	0	0	471	0
6	21	28	1	0	0	479	5
6	22	29	2	0	0	488	1
6	23	27	0	0	0	496	4
6	24	24	8	0	0	504	3
6	25	24	8	0	0	476	0
6	26	25	3	0	0	483	9
6	27	17	0	1	0	490	4
6	28	15	3	0	0	496	5
6	29	21	4	0	0	503	8
6	30	19	2	0	0	510	7
7	1	24	8	0	0	518	8
7	2	25	9	0	0	527	2
7	3	15	3	9	7	486	7
7	4	16	4	6	4	467	3
7	5	18	1	0	0	474	3
7	6	21	4	0	0	481	8
7	7	20	3	0	0	489	2
7	8	18	1	0	0	496	2
7	9	20	9	0	0	503	6
7	10	13	1	8	9	469	4
7	11	14	8	4	1	462	4
7	12	22	0	0	0	470	1
7	13	22	0	0	0	477	7
7	14	23	7	0	0	485	7
7	15	23	1	0	0	493	5
7	16	25	9	0	0	501	9
7	17	25	9	0	0	510	3
7	18	24	8	0	0	518	4
7	19	28	7	0	0	527	3
7	20	29	8	0	0	536	4
7	21	29	2	0	0	545	3
7	22	29	8	0	0	554	4
7	23	28	7	0	0	563	3
7	24	23	7	0	0	571	3
7	25	18	1	0	0	578	2
7	26	21	4	0	0	585	8
7	27	25	9	0	0	594	1
7	28	27	6	0	0	602	8
7	29	27	6	0	0	611	5
7	30	25	9	0	0	619	8
8	1	24	8	0	0	628	0
8	2	24	2	0	0	635	4
8	3	22	6	0	0	642	4
8	4	24	2	0	0	649	5
8	5	26	4	0	0	656	9
8	6	26	4	0	0	664	6
8	7	23	7	0	0	672	4
8	8	23	1	0	0	679	7
8	9	24	8	0	0	686	8
8	10	25	3	0	0	694	3
8	11	24	8	0	0	701	9
8	12	24	8	0	0	709	3
8	13	22	6	0	0	716	8
8	14	18	1	0	0	723	9
8	15	12	6	0	8	698	8
8	16	17	6	1	8	704	0
						710	2

Table 12

 *****BANFF NATIONAL PARK DROUGHT CODE VALUES**

CARRY-OVER VALUE: 0-dc

Station is Lake Louise; Overwinter Mean = ⁴⁰⁰ mm
 Year = 1936

4	1	-10.8	0.0	0.4
4	2	-9.1	0.0	0.9
4	3	-6.9	0.0	1.3
4	4	-6.3	0.0	1.8
4	5	-1.9	0.0	2.4
4	6	0.3	0.0	3.4
4	7	1.4	0.0	4.6
4	8	0.9	0.0	5.7
4	9	5.9	0.0	7.8
4	10	2.6	0.0	9.2
4	11	-2.6	10.2	1.4
4	12	5.2	3.8	1.7
4	13	4.9	0.0	3.7
4	14	3.1	0.0	5.2
4	15	-8.7	0.0	7.8
4	16	13.1	0.0	11.1

overwinter precip.=114.5

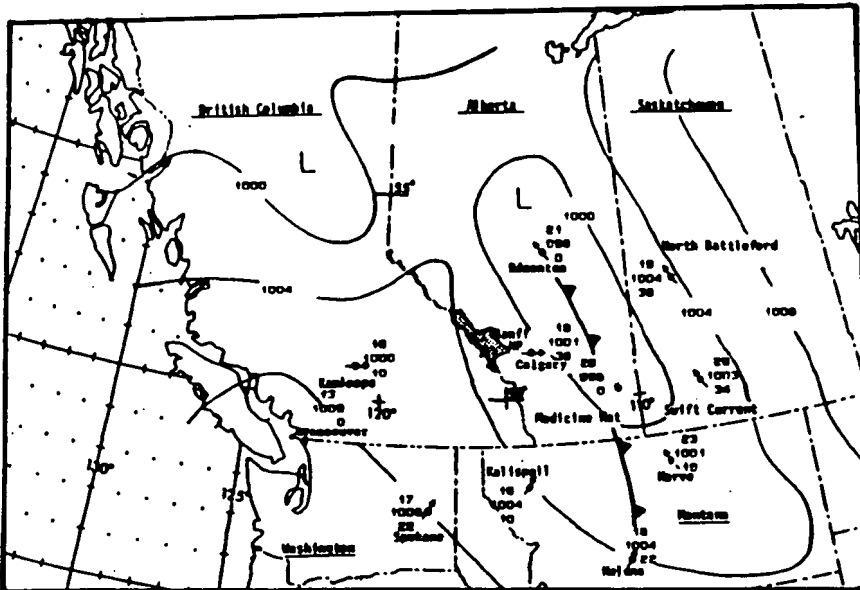
Spring Start-up Value= 33.1

4	17	15.3	0.0	36.8
4	18	18.1	0.0	41.0
4	19	10.9	0.0	43.9
4	20	4.2	0.0	45.6
4	21	2.6	2.5	47.1
4	22	5.3	5.1	42.5
4	23	3.1	5.1	37.5
4	24	7.0	0.0	39.8
4	25	5.9	0.0	41.8
4	26	7.6	0.0	44.1
4	27	7.0	5.8	38.6
4	28	6.4	0.0	40.7
4	29	12.6	0.0	43.9
4	30	12.6	0.0	47.1
5	1	12.0	0.0	51.7
5	2	10.9	0.0	56.1
5	3	13.7	0.0	60.9
5	4	14.8	1.8	66.0
5	5	8.1	3.3	66.5
5	6	9.8	0.0	70.6
5	7	9.2	0.0	74.7
5	8	9.2	0.0	78.8
5	9	14.2	0.0	83.7
5	10	9.8	0.0	87.9
5	11	7.0	0.6	81.8
5	12	13.7	0.0	86.6
5	13	17.0	0.0	92.1
5	14	22.0	0.0	98.5
5	15	11.4	0.0	99.9
5	16	8.7	3.8	103.8

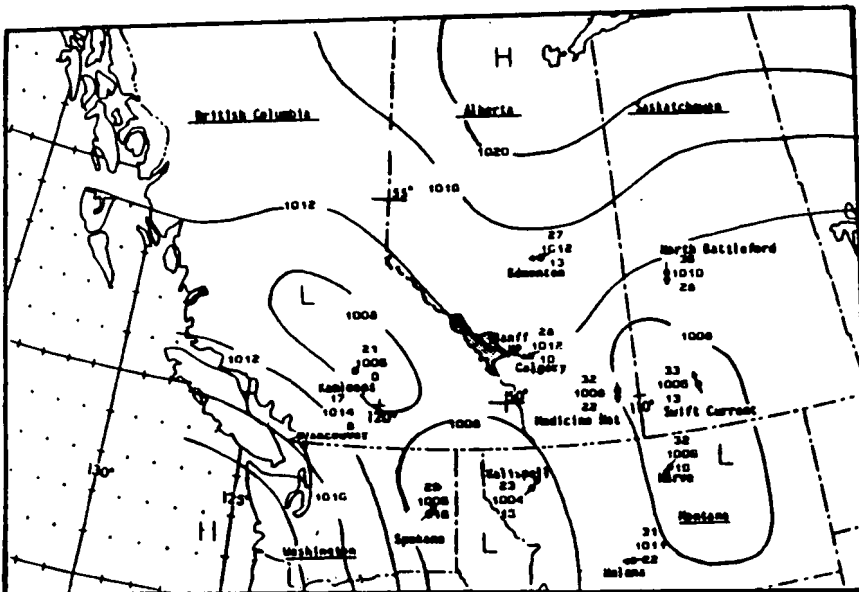
5	17	8.7	0.0	107.8
5	18	16.4	0.0	113.2
5	19	17.0	0.0	118.6
5	20	6.4	1.3	122.2
5	21	6.4	0.5	125.7
5	22	9.2	0.0	129.8
5	23	13.7	0.0	134.7
5	24	15.3	0.0	139.8
5	25	23.1	0.0	146.4
5	26	26.4	0.0	153.5
5	27	26.4	0.0	160.7

5	26	26.4	0.0	153.5
5	27	26.4	0.0	160.7
5	28	25.3	0.0	167.7
5	29	28.1	3.8	169.5

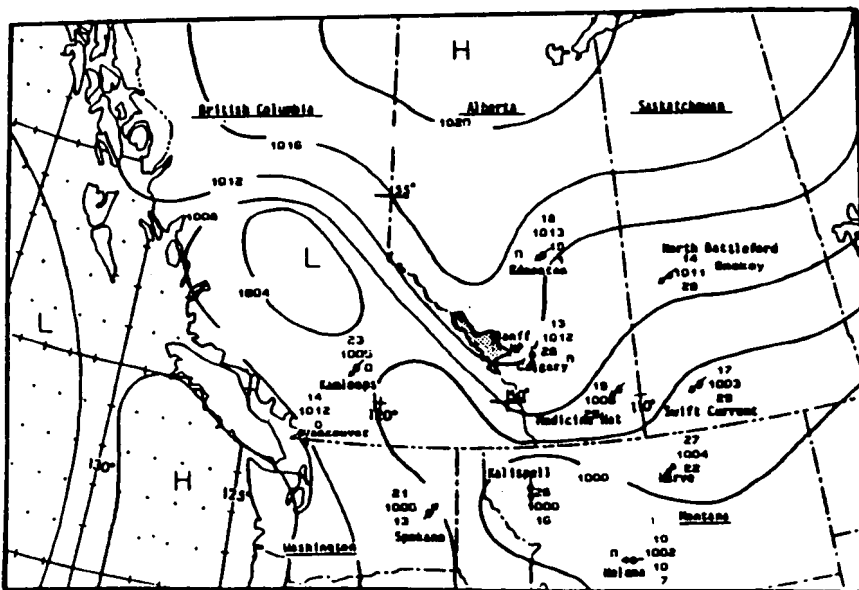
6	0	0	0	177.1
6	0	0	0	183.6
6	0	0	0	170.6
6	0	0	0	176.5
6	0	0	0	182.8
6	0	0	0	148.3
6	0	0	0	138.1
6	0	0	0	137.0
6	0	0	0	142.0
6	0	0	0	147.4
6	0	0	0	153.6
6	0	0	0	152.1
6	0	0	0	138.9
6	0	0	0	144.4
6	0	0	0	136.8
6	0	0	0	138.5
6	0	0	0	134.8
6	0	0	0	140.8
6	0	0	0	145.8
6	0	0	0	151.7
6	0	0	0	159.2
6	0	0	0	167.3
6	0	0	0	174.8
6	0	0	0	183.2
6	0	0	0	190.9
6	0	0	0	198.7
6	0	0	0	206.2
6	0	0	0	213.9
6	0	0	0	219.8
6	0	0	0	225.0
6	0	0	0	231.6
6	0	0	0	238.9
6	0	0	0	246.7
6	0	0	0	238.6
6	0	0	0	230.6
6	0	0	0	237.7
6	0	0	0	243.7
6	0	0	0	245.9
7	7	15.9	3.0	252.3
7	7	15.9	3.0	259.2
7	7	15.9	3.0	234.5
7	7	15.9	3.0	240.5
7	7	15.9	3.0	248.0
7	7	15.9	3.0	255.5
7	7	15.9	3.0	263.5
7	7	15.9	3.0	270.5
7	7	15.9	3.0	278.6
7	7	15.9	3.0	286.8
7	7	15.9	3.0	294.9
7	7	15.9	3.0	303.6
7	7	15.9	3.0	312.5
7	7	15.9	3.0	321.2
7	7	15.9	3.0	329.9
7	7	15.9	3.0	338.2
7	7	15.9	3.0	345.4
7	7	15.9	3.0	352.4
7	7	15.9	3.0	359.9
7	7	15.9	3.0	367.7
7	7	15.9	3.0	376.0
7	7	15.9	3.0	384.4
7	7	15.9	3.0	392.7
7	7	15.9	3.0	400.6
7	7	15.9	3.0	407.4
7	7	15.9	3.0	414.2
7	7	15.9	3.0	421.1
7	7	15.9	3.0	428.0
7	7	15.9	3.0	435.5



Map # 72: Surface Map:
May 4, 1936 - 8:00 p.m.

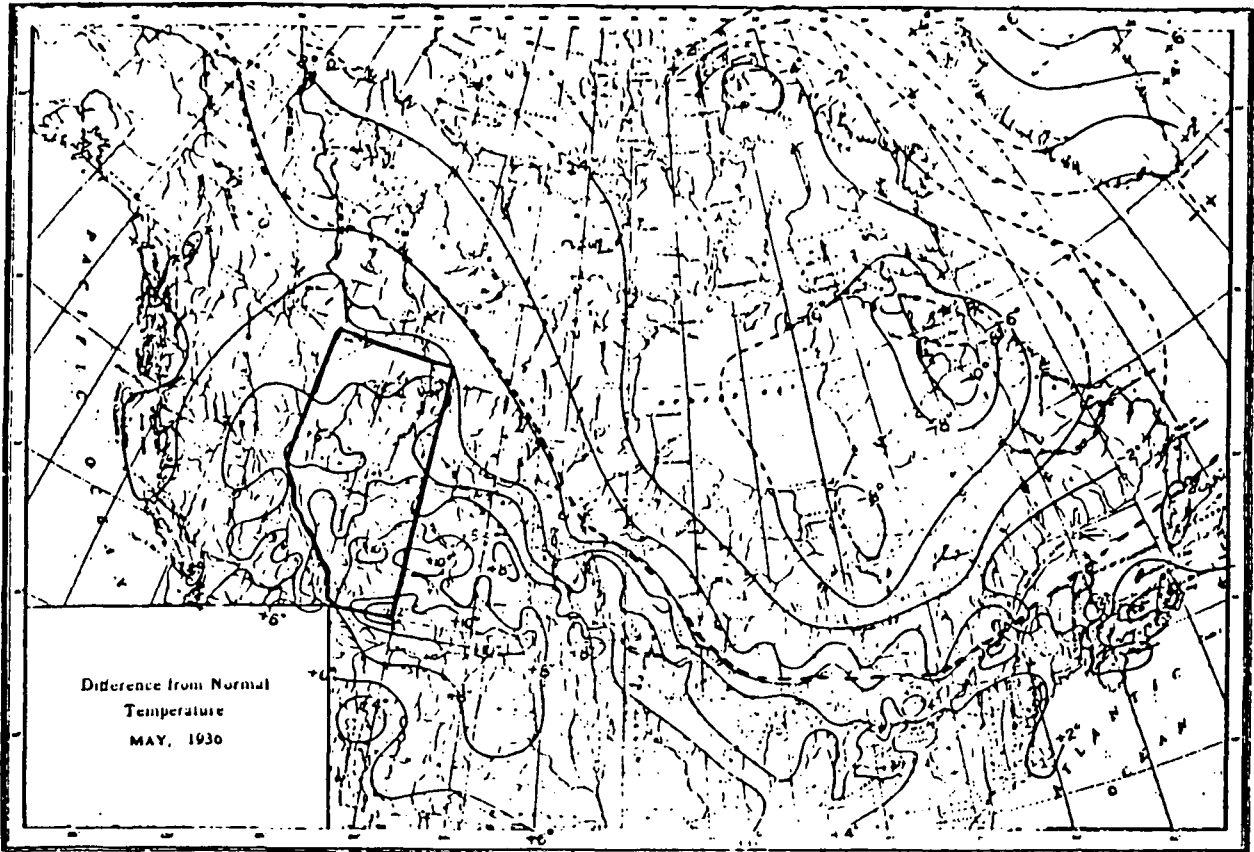


Map # 73: Surface Map:
May 30, 1936 - 8:00 p.m.

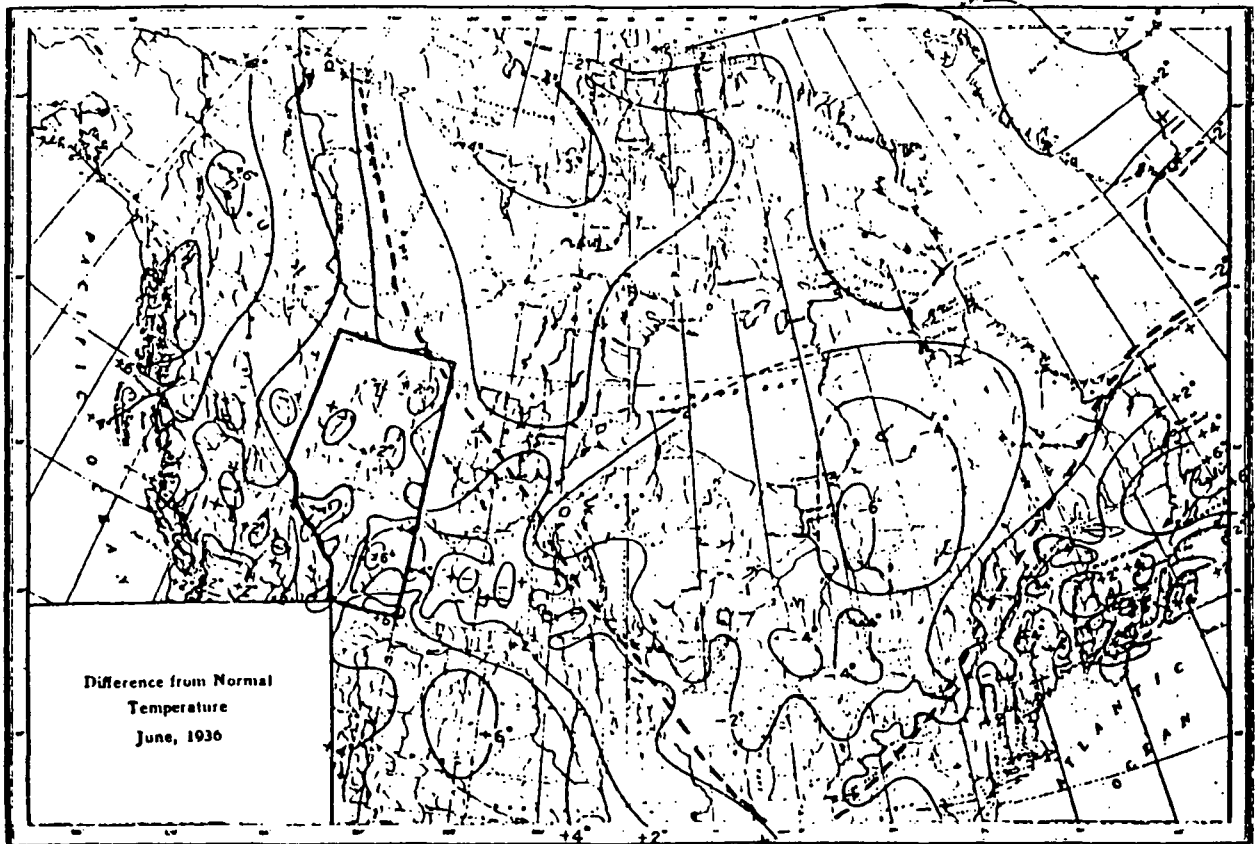


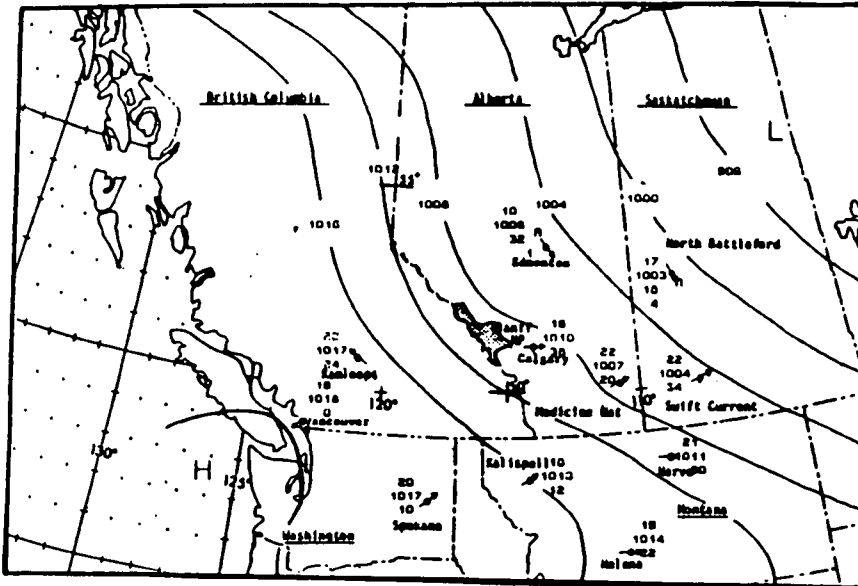
Map # 74: Surface Map:
June 1, 1936 - 8:00 p.m.

Map # 75: Difference from Normal Temperature May, 1936

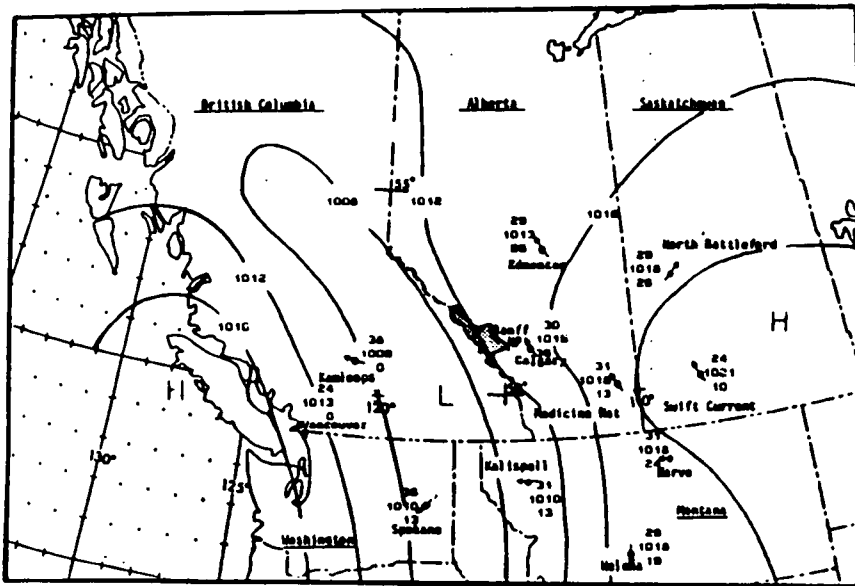


Map # 76: Difference from Normal Temperature June, 1936

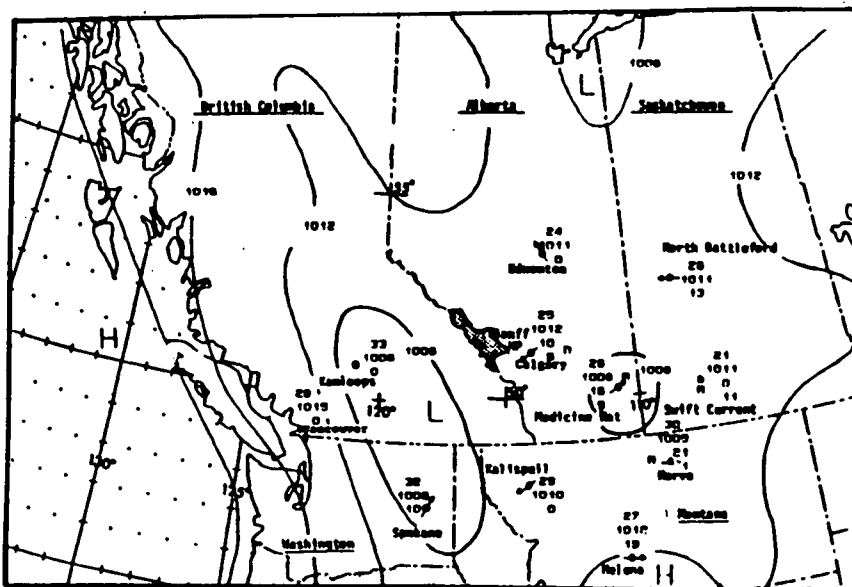




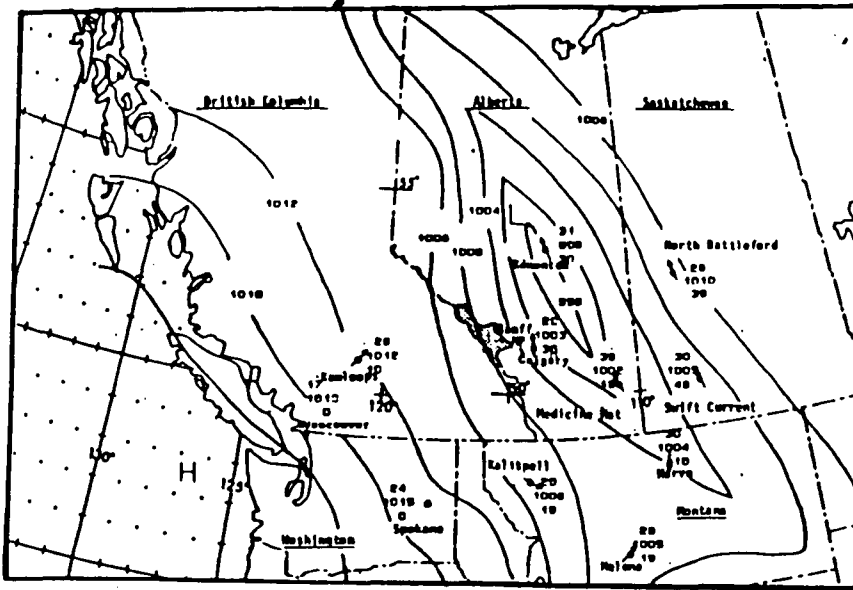
Map # 77: Surface Map:
June 18, 1936 - 8:00 p.m.



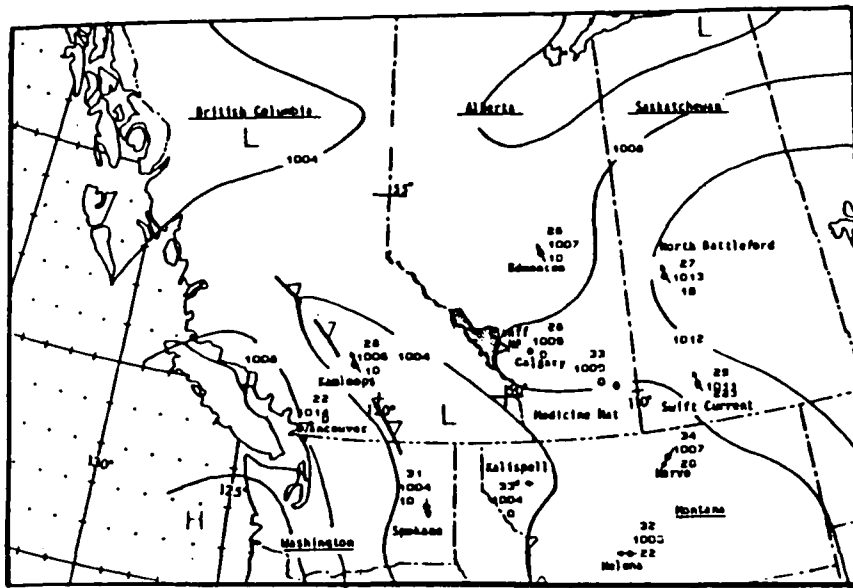
Map # 78: Surface Map:
June 22, 1936 - 8:00 p.m.



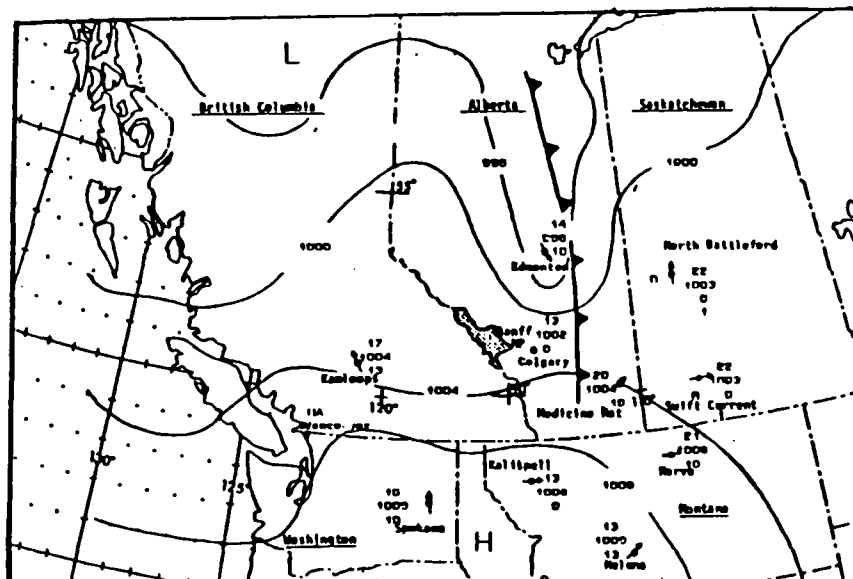
Map # 79: Surface Map:
June 25, 1936 - 8:00 p.m.



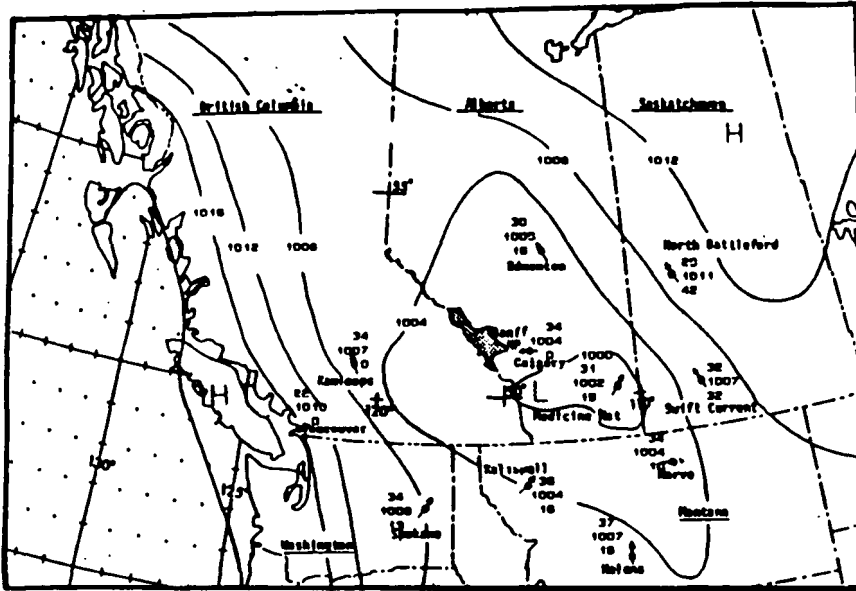
Map # 80: Surface Map:
June 27, 1936 - 8:00 p.m.



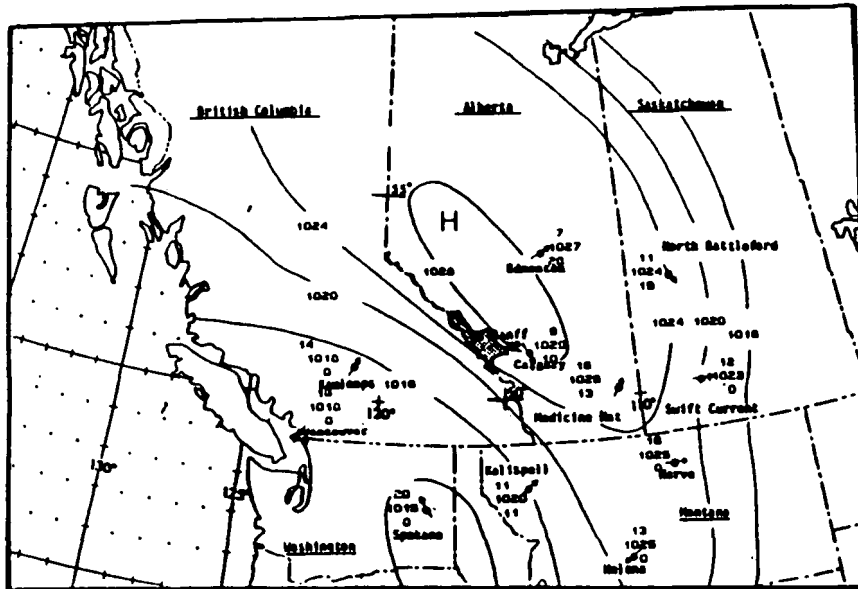
Map # 81: Surface Map:
July 2, 1936 - 8:00 a.m.



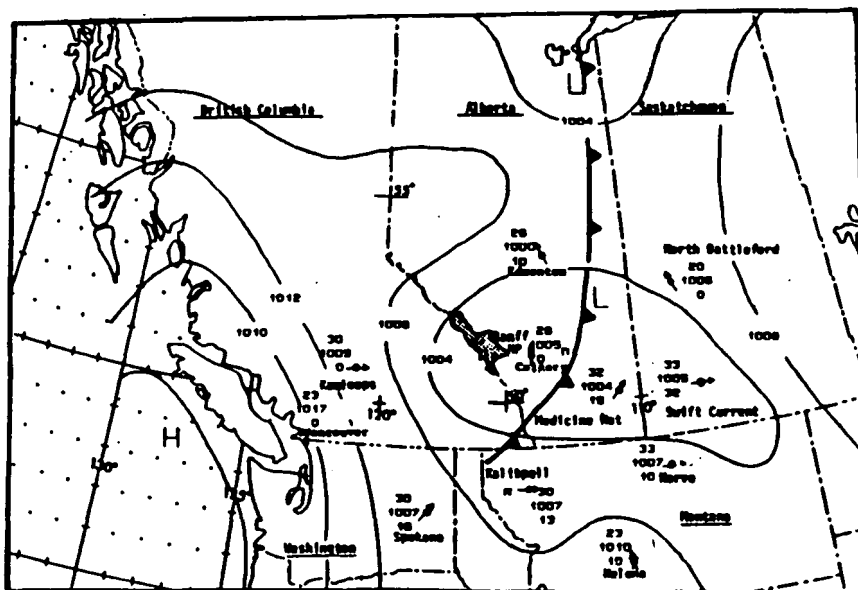
Map # 82: Surface Map:
July 10, 1936 - 8:00 a.m.



Map # 83: Surface Map:
July 22, 1936 - 8:00 p.m.

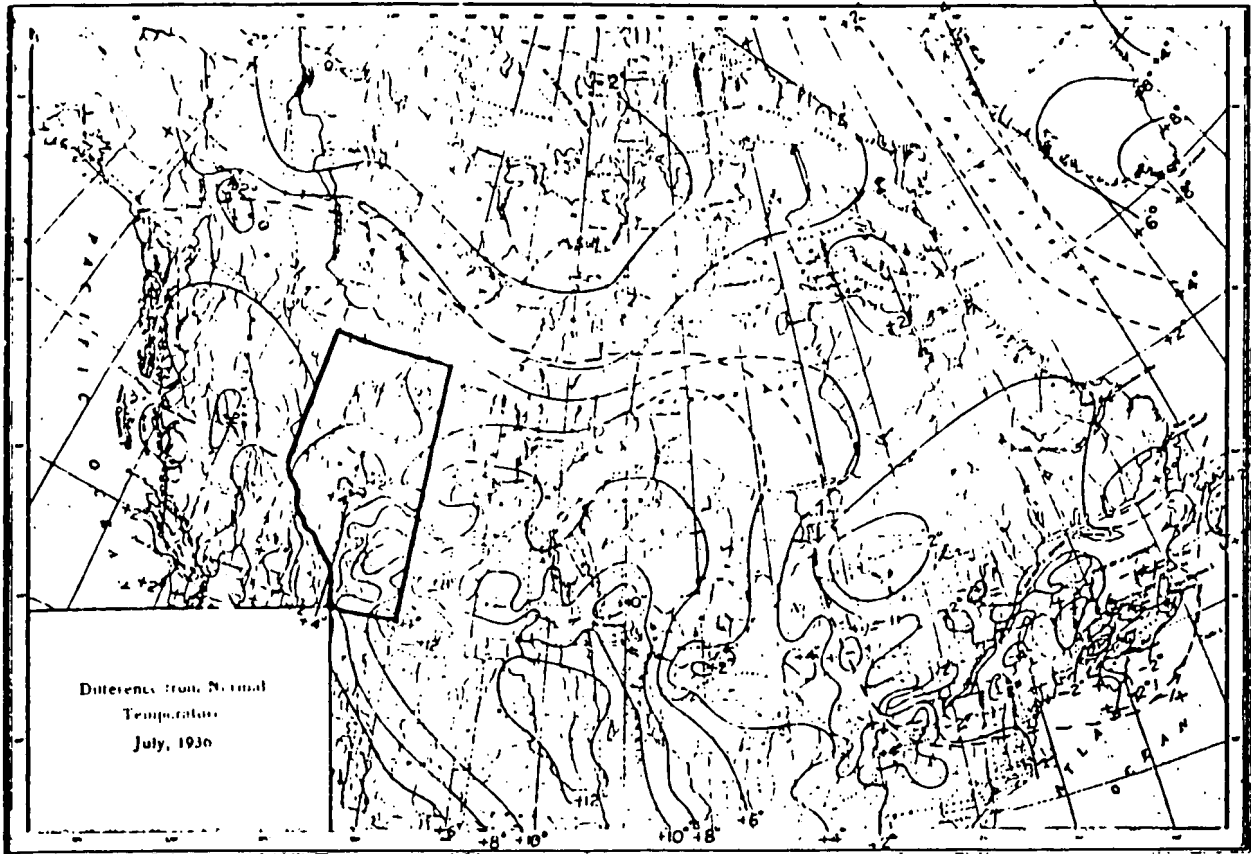


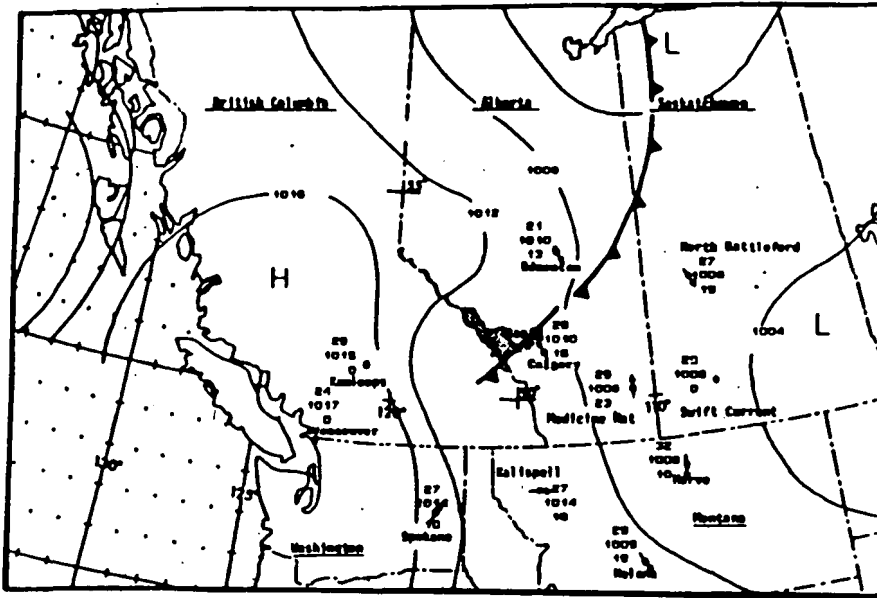
Map # 84: Surface Map:
August 2, 1936 - 8:00 p.m.



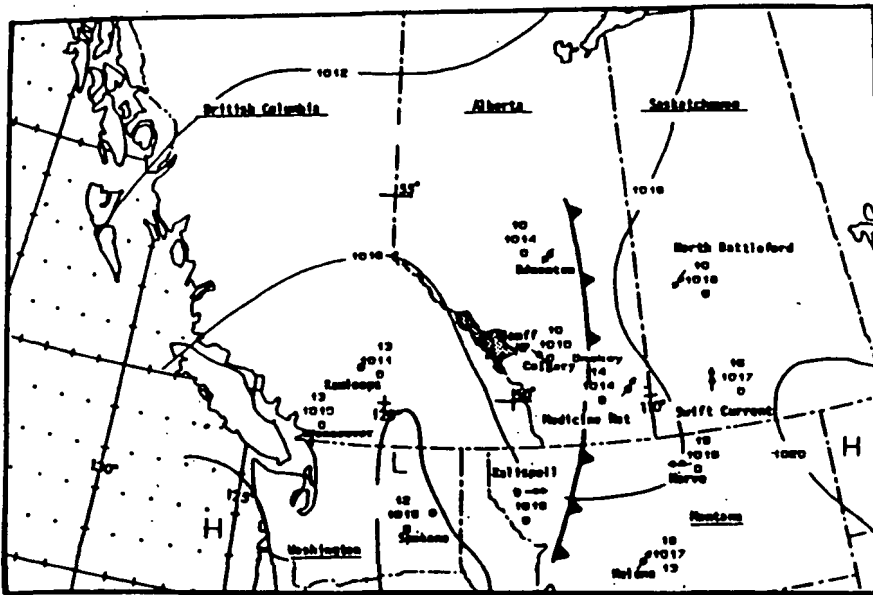
Map # 85: Surface Map:
August 6, 1936 - 8:00 p.m.

- 96 -
Map # 86: Departures from Normal Temperatures July, 1936

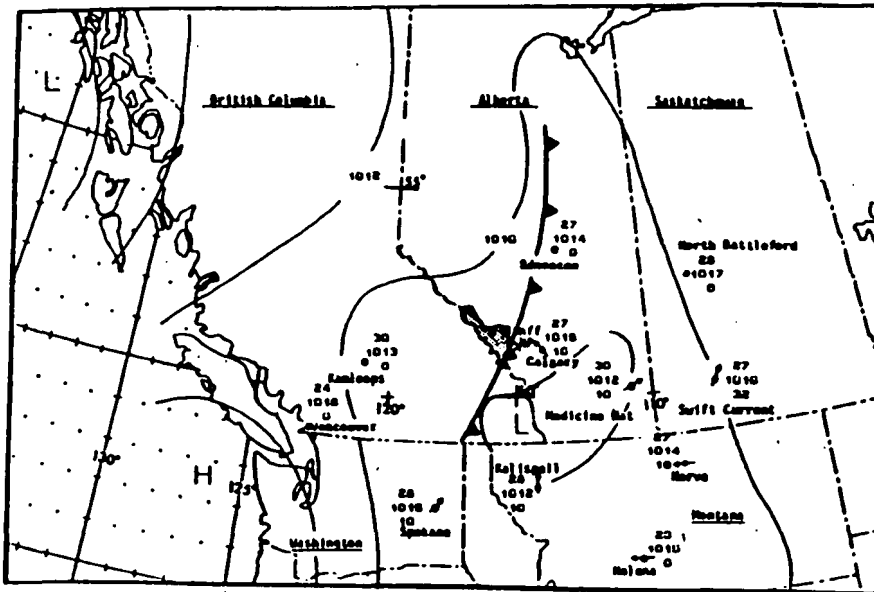




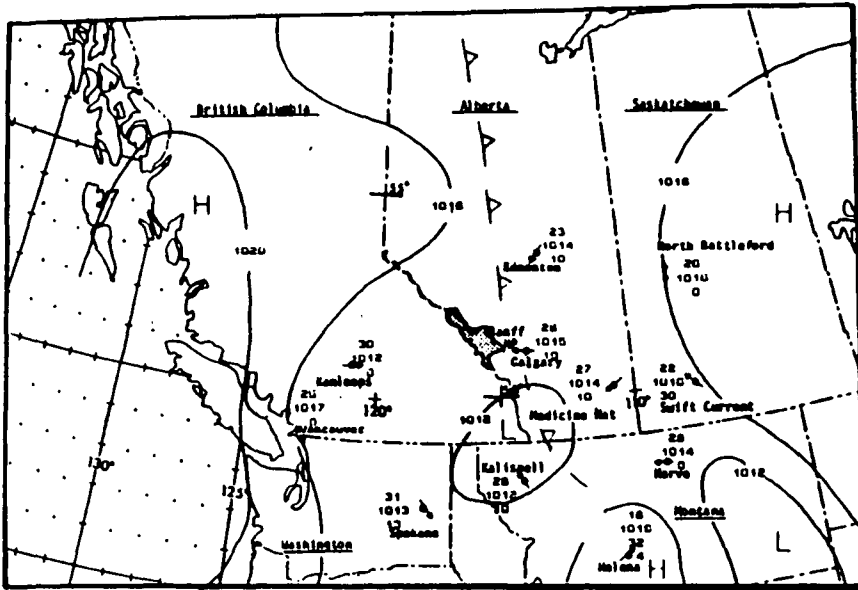
Map # 88: Surface Map:
August 7, 1936 - 8:00 p.m.



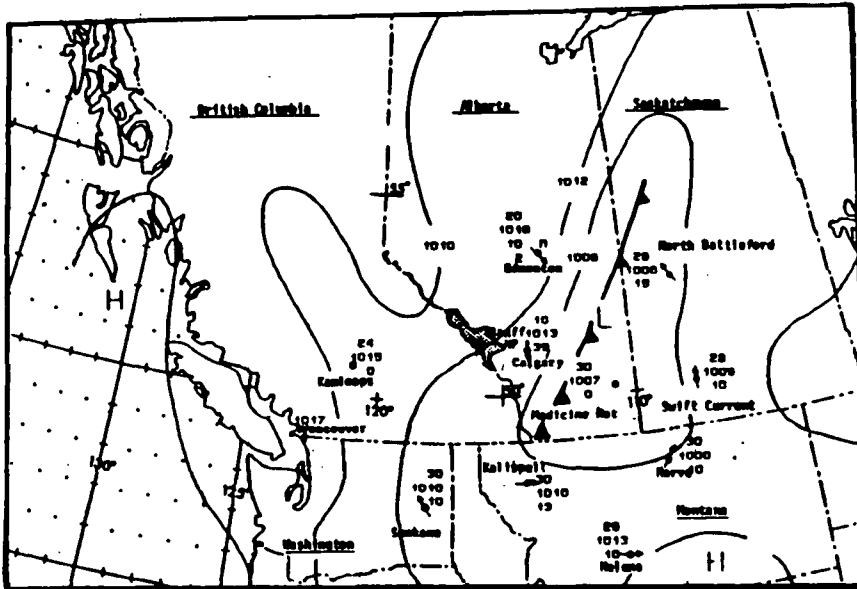
Map # 89: Surface Map:
August 9, 1936 - 8:00 p.m.



Map # 90: Surface Map:
August 11, 1936 - 8:00 p.m.



Map # 91: Surface Map:
August 12, 1936 - 8:00 p.m



Map # 92: Surface Map:
August 13, 1936 - 8:00 p.m

Upon examining Lake Louise drought-code data for 1936, it initially appeared that the winter and spring had not been as dry as in Banff. The start-up drought-code for Lake Louise was 33.1, not excessively high. However, over-winter precipitation was 70.7% of the normal, indicating that a moisture deficit had occurred but was not revealed by drought-code values. Reasons for such discrepancy are unknown.

During May three storms brought precipitation to Banff and Lake Louise. Two of these storms resulted from low pressure systems with their accompanying cold fronts passing through Alberta. They influenced Banff's weather on the 10th and 11th, and, on the 20th, rain was recorded at Banff and Lake Louise. The third disturbance was caused by a deep low in the Alaska panhandle, extending a trough and cold front through British Columbia and Alberta. Map # 72 illustrates this situation which brought 9.9 mm of precipitation to Banff on the 4th. This system appears not to have had as large an influence on Lake Louise weather as only 4.1 mm of rain was recorded on the 4th and 5th.

May was an extremely warm month, with daily high temperatures exceeding average monthly high temperature on 20 days, and therefore having a mean monthly high 3.1°C above the normal of 14.2°C . This occurrence, along with the monthly precipitation deficit, was most certainly the result of an upper blocking ridge persisting over Canada. This theory of course will never be proved due to the total lack of upper air measurements in 1936. This proposed ridge is the same sort of phenomena responsible for similar climatological trends in today's weather. Map # 75, Deviations from Normal Temperatures, illustrates the extent of this proposed ridge (shown by dashed line).

As the month of May, 1936, came to an end, temperatures rocketed to 28.7°C on the 30th. Map # 73 depicts the synoptic situation which resulted in such almost record breaking temperatures. The intense high pressure system over the northern prairie provinces promoted clear skies, and temperatures throughout southern Saskatchewan ranged from $30-34^{\circ}\text{C}$. As southern Alberta was under similar conditions and an easterly flow, upslope winds were hot and dry. Rain had fallen on 7 days (normal 12) and, with excessively hot temperatures, drought-codes were 479 and greatly above normal.

June was a relatively cool month in Banff, with daily high temperatures exceeding the average daily high on only 12 days. The average daily high was 3.2° below normal. Banff received precipitation on 9 days during the month (normal 13), for a total of 76.5 mm or 75% of the normal June precipitation. The most significant storm of the month occurred on June 1st, when a badly needed 16.5 mm of rain fell in Banff; 11.4 mm of rain fell on Lake Louise the same day. Map # 74 depicts the disturbance which brought rain. An intense high in the North West Territories resulted in upslope winds and, in conjunction with a weak low in British Columbia, resulted in orographic precipitation on the eastern slopes. Temperatures remained in the teens for the first week of June until an arctic high brought extremely low temperatures on the 6th and 7th. As upslope wind conditions occurred on the 7th, temperatures fell to a low 2.6°C, and 4.1 mm of rain was recorded in Banff. This system brought more severe weather to Lake Louise and, on the 5th, 6th and 7th, with 29.2 mm of rain being recorded. Until the middle of the month, a series of ridges and troughs passing over the Banff area resulted in unsettled weather. Temperatures fluctuated in the teens and light precipitation fell on 6 days.

Synoptic Situation Immediately Preceding and During the Silverhorne Fire

Map # 77 illustrates the synoptic situation of June 18th. As seen on this map, a low pressure system over the Hudson's Bay and a high off the coast brought a northerly flow and cool temperatures. As this high pressure system moved inland, temperatures rose as the weather became clear, hot and dry. By the 22nd and 23rd, (Map # 78), the high pressure system had moved inland over the prairies and a weak trough in British Columbia brought southerly winds and temperatures in the high 20's. This system remained quasi-stationary and, as the Hudson's Bay high tracked northeast on the 24th, the British Columbia low expanded and lay over Alberta and Saskatchewan. Temperatures were moderate but the system brought no rain. On the 25th this low pressure system weakened considerably and a weak cold front lay over eastern Alberta (see Map # 79). Winds were most likely variable and temperatures remained in the mid 20's. Under these weather conditions, drought-code values were approximately 500 or 260 points above normal. This unsettled weather on the 25th resulted in dry lightning near Mistaya Lake, and the Silverhorne fire was off and burning.

Little information is available concerning the Silverhorne fire but it appears to have burned in a southeasterly direction for 4 km, then blew-up into a crown fire and raced up Weed Mountain in a north easterly direction. On the 25th winds were most likely variable and the fire burned in a south easterly direction against the gradient flow. As the 26th passed, the British Columbia low pressure system reorganized, as a Yukon high pressure system pushed southward into Alberta. This low continued to intensify as it was squeezed between a high in Alberta and a high off the coast. A distinct cold front lay on a northwest-southeast orientation, by the evening of the 26th. The fire was probably still burning in a southeast direction against the gradient flow. Then, on the 27th, during the day, the British Columbia low, now very intense, made rapid movements in a northeasterly direction as the high off the coast pushed inland. As the front passed during mid-day, the fire blew-up and, under strong south westerly winds, burned up Weed Mountain as a crown fire. Map # 80 illustrates the synoptic situation on the evening of the 27th.

This low pressure system brought variable rains, as it built and tracked east. On the 25th rain was recorded in Banff but none fell in Lake Louise. Then, on the 26th, less than 1 mm fell in Lake Louise - but none in Banff. On the 27th Banff received 1 mm of precipitation and Lake Louise recorded 1.5 mm of rainfall. No mention of rain is made in Carlton's documentation of the Silverhorne fire. This may indicate that little if any rain fell in the Silverhorne area during these three days. With the passage of the cold front, temperatures dropped quickly and on the 28th, the temperature reached 13°C at Lake Louise. As a result of cool temperatures and undoubtedly some precipitation, fire activity subsided. Throughout the rest of the month and the beginning of July, temperatures remained cool and mop-up efforts controlled fire spread. As another low pressure system developed in British Columbia on the 2nd, (Map # 81), and tracked east on the 3rd and 4th, 12.6 mm of rain fell in Lake Louise and 16.1 mm fell in Banff. This precipitation assured the cessation of the Silverhorne fire.

As previously mentioned, June was a relatively cool month with moderately subnormal precipitation. The upper ridge, which had persisted throughout May appears to have weakened and may have receded back over the Pacific. Map # 76 depicts Banff under the tail end of this upper ridge and, although temperatures

in Banff were slightly subnormal, most of Southern Alberta experienced a warm month. This proposed ridge, although not strong over Banff, may have directed storm tracks northeast and south of Banff. This theory would explain the lack of precipitation in June.

Synoptic Situation Immediately Preceding and During
Flints Park and Howse Pass Fires

Temperatures had risen throughout the next week, as Banff was primarily influenced by high pressure. On July 10, as shown in Map # 82, a deep low in the North West Territories was extending a trough through Alberta. Associated with this trough was a well defined cold front and a high pressure cell in the Pacific. This high pressure cell pumped moist inactive air over the mountains and, as it rises and runs over the top, the cool, low precipitation was recorded in Banff and Lake Louise. Thirteen millimeters of rain fell in Banff on the 10th and 11th, as this system remained quasi-stationary. Fourteen millimeters fell in Lake Louise. This badly needed precipitation dropped drought-codes by 41 points in Banff (now 462.4) and 25 points in Lake Louise (now 240.5). This was the last precipitation to fall for 33 days in Banff and 26 days in Lake Louise.

Beginning on the 12th of July, and continuing until the 13th of August, temperatures in Banff exceeded 20°C every day except one (July 25th temperature 18.1°C). A similar pattern occurred in Lake Louise but temperatures dropped below 20°C on 2 other days. This high temperature trend and lack of precipitation resulted in drought-code values increasing by 238 points in Banff, and by August 13th was at a value of 723.9. Similarly, in Lake Louise, drought-codes increased by 237 points to 485.1 on the 12th of August. The peak of this hot, dry spell occurred on July 22, when temperatures rose to 29.8°C. Map # 83 July 22, depicts the synoptic situation which brought such high temperatures. Although not shown on this map, an intense high pressure system in the central mid-west, and a high in the northern prairie provinces, forced, hot, dry air into Alberta from the south and from the east.

The synoptic pattern remained quasi-stationary on the 23rd of July and played a key role in the spread of a large Elk Valley, British Columbia fire

which burned across Weary Gap into Alberta. This fire continued to burn 25,000 ha in Alberta. South westerly winds and high temperatures were the factors which blew the fire into Alberta. Temperatures moderated somewhat on the 24th and 25th, as the low deepened and gradient flow came from the north. Throughout the remainder of the month, temperatures remained in the mid to high twenties, as Alberta experienced clear, dry days and warm temperatures.

As July came to an end, the average daily high had exceeded the norm of 22.3°C by .85°C, and rainfall had been 68.4% of the normal. Once again, the persistence of an upper high during the last two weeks of July was probably responsible for the above normal temperatures and below normal precipitation. Map # 86, Deviations from Normal July Temperatures, depicts the approximate boundaries of such a high as shown by the dotted line. Banff was on the leading edge of this high, with southern Manitoba and Saskatchewan being affected the greatest. This upper high appears to have compressed and tracked west in August, and was undoubtedly responsible for the extreme drying which occurred during the last two weeks of July and the first two weeks of August.

The beginning of August was dominated by high pressure, clear skies, and warm temperatures. Map # 84 depicts a strong high which lay over Alberta on the 2nd of August. As a result of having an arctic origin, this high pressure system brought warm but not hot temperatures to the Banff area. This system dominated weather in the Banff area until the 5th, when a weak trough and cold front extended through Alberta. Prefrontal temperatures were hot, as Banff temperatures rose to 26°C and Calgary temperatures rose to 31°C. As the Pacific high of the previous day pushed inland, the low deepened and the cold front became more distinct on the 6th (see Map # 85). This was the first day of the Flints Park fire and, although the fire is believed to have ignited as a result of an outfitters camp, the synoptic situation could also have brought dry lightning. The cold front shown on the August 6th map undoubtedly had some effect on the first day fire behavior, but it appears to have stayed southeast of Banff. Winds were most likely variable on the 6th but all Alberta stations reported south winds. Temperatures remained in the mid twenties throughout the day. Banff drought-codes on the 6th were at a high 672.4 points - 264 points above normal.

On the 7th of August a high pressure system off the B.C. coast pushed inland and forced the previous day's low northeast. The cold front from the low appears to have remained quasi-stationary on the 7th, as shown in Map # 88 , and probably had a significant effect on fire behavior. Winds in Banff were most likely from the west-northwest, and the fire burned down the valley towards Cuthead Creek. By the 8th barometric pressure was rising as the coastal high continued its inland movements, and geostrophic flow was out of the northwest. The upper Cascade Valley is oriented on a west-southwest/east-northeast direction; as a result, any winds with a slight westerly orientation are funneled down the valley. This characteristic brought about the down valley east-northeast burn. On the 8th a low pressure system in the Alaska panhandle was influencing weather in Northern B.C., and, by the 9th, had extended a trough and weak cold front through Alberta. Temperatures had fallen slightly as Banff was under a predominately northwest flow.

August 9th was a major day in the fire history of the Kananaskis Valley. As Ranger P. Campbell described that day --"A large portion of the valley burned under gale force winds in the afternoon. By six PM of the 9th, the Kananaskis Valley was all on fire for a distance of six miles long and three miles wide." This erratic and intense fire behavior was probably a result of the cold front affecting weather in the Kananaskis (see Map # 89).

Barometric pressure began to rise on the 10th, as a high pressure system off the B.C. coast pushed inland; temperatures remained in the mid twenties, as wind came out of the northwest. Temperatures and barometric pressure dipped, as Alberta's weather was dominated by a trough on the 11th. (see Map # 90), and winds were variable behind the weak cold front extending through Alberta. This system weakened on the 12th (see Map #91), and a fire, which had been burning in British Columbia, crossed over the Divide into the Howse Pass area of Banff National Park. Contrary to geostrophic flow, the fire burned in a northeasterly direction, downhill through Howse Pass.

Synoptic Situation at the End of the Howse Pass
and Flint Park Fires

On the 13th of August (Map # 92), the previous day's low intensified as it was squeezed between high pressure systems on the east, west and south. A well developed cold front extended through Alberta and 6.9 mm of rain fell in Lake Louise. Showers seemed spotty over the Rockies, as this low developed and tracked west. The Crag and Canyon reported rain on the 12th at the Flints Park fire. The Howse Pass fire continued to burn northeastward into the wind on the 13th (Carleton 1961), and it wasn't until the 14th that Banff reported rainfall, (4.8 mm). Lake Louise also reported rain on the 14th and 15th. This precipitation assured the cessation of both Flints Park and Howse Pass fires.

Upon examining the map, Deviations from Normal Temperatures, (Map #87), it is obvious that, during August, temperatures were in excess of the norm over much of the province. The first thirteen days of August all had daily high temperatures greater than the normal daily high. Only 2 other days, outside of these first 13, had temperatures exceeding the average daily high, and the monthly high temperature averaged 20.5°C. This obviously indicates the existence of unusual synoptic patterns throughout the first two weeks of August. In all likelihood, the continuance of July's upper ridge was the cause. Precipitation for the month was 33% of the norm, and this also suggests: that an upper blocking high prevented cyclonic disturbances from bringing precipitation. The dashed line on Map # 87 indicates the probable location of ridge boundaries. Note that Banff lay to the northeast of the central core of the ridge which was located over Nebraska and Iowa. The breakdown of this upper ridge most likely began on July 30th or 31st, and once it had significantly broken down cyclonic disturbance, now not being blocked, brought precipitation to the Rockies and relief to fire fighters. Jerome Namias (1980) documented the occurrence of the 1936 upper ridge. His theories will be discussed in the conclusion of this report.

SASKATCHEWAN CROSSING FIRE JULY 2-7, 1940

General Description

During the summer of 1940 approximately 4200 ha of Banff National Park burned --- 4000 of which was consumed by one fire, the Saskatchewan Crossing Fire. The fire began on July 3 and, although the ignition source is unknown, synoptic patterns suggest a dry lightning strike was responsible. Rate of spread of this fire appears to be extremely rapid until the 5th, when it was drenched by rain. The fire was classified as extinguished on the 7th.

The synoptic patterns which brought about such explosive fire behavior and, in particular, the subsequent demise, are perhaps the most intriguing of all the situations scrutinized. They are definitely the most complex and least distinct. Therefore they are also the most subject to debate.

This season's analysis will incorporate information published in 1940 by the United States Weather Bureau in Detroit Michigan. These Monthly Weather Reviews, although strictly for the United States, have some application to Canadian climate, as will be revealed within the analysis. In particular, isobar charts for 1524, 3000 and 5000 meter elevations will be referenced. These charts also include isotherms for the U.S. and wind speed and directions for the appropriate altitudes. These charts are some of the first examples of upper air measurement. Their interpretation is useful in analyzing upper air development and resulting surface formation, and therefore subsequent fire effects. As opposed to today's upper air measurements, these 1940 interpretations used elevation as a constant rather than pressure. Although modifying methods of interpreting upper air ridge and trough development, they reveal the same basic principles.

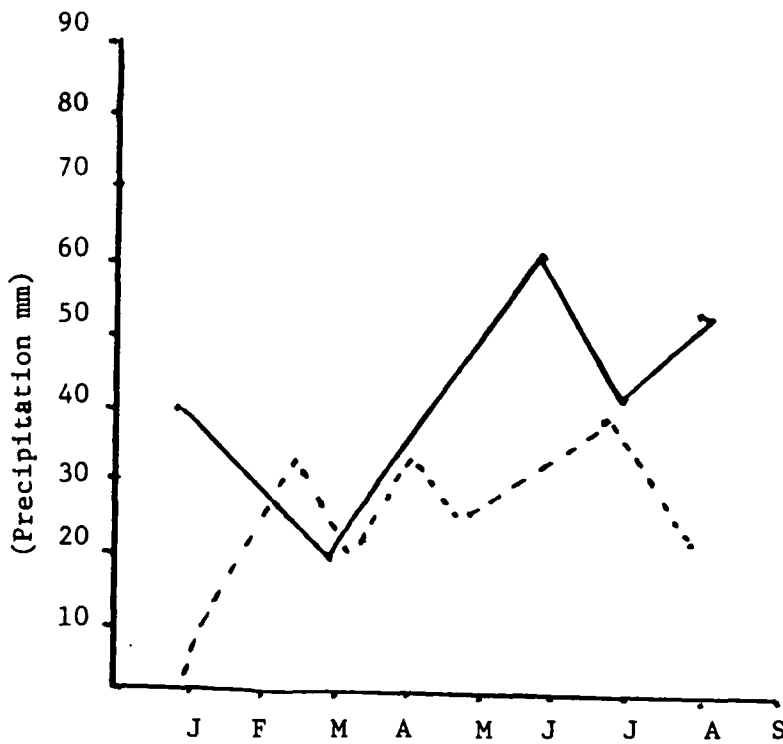
Synoptic Situation in Months Preceding the Saskatchewan Crossing Fire

Table # 13 and Graph # 7 denote the precipitation tendencies which contributed to the occurrence of a bad fire season in 1940. Over winter, precipi-

Table # 13: Banff Monthly Precipitation, 1940

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May.</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Total</u>
1940	0.66	3.55	1.80	3.68	2.31	2.49	3.99	1.93	26.41
Avg. 51-80	3.82	2.78	2.09	3.76	5.18	6.13	4.24	4.89	32.89
% of Norm.	17.3	128.0	86.0	97.9	44.6	40.6	94.0	39.5	80.29

Graph # 7: Precipitation Trends 1940



BANFF NATIONAL PARK DROUGHT CODE VALUES

CARRY-OVER VALUE: 54-dc

Station is Banff; Overwinter Mean = 179mm
Year = 1940

4	1	-2.4	4.6	48.9
4	2	-5.6	7.1	39.2
4	3	-2.4	2.5	39.7
4	4	5.3	0.0	41.6
4	5	4.8	0.0	43.4
4	6	6.4	0.0	45.5
4	7	2.0	2.0	46.8
4	8	2.6	0.5	48.3
4	9	-3.0	6.4	39.8
4	10	-6.3	1.8	40.3
4	11	3.1	0.0	41.8
4	12	12.6	0.0	45.0
4	13	13.1	0.0	48.3
4	14	7.6	0.0	50.6
4	15	3.1	0.0	52.2
4	16	6.4	0.0	54.3
4	17	8.7	2.0	56.8
4	18	9.2	2.0	59.4
4	19	9.2	0.0	62.0
4	20	3.1	1.5	63.5
4	21	3.7	0.0	65.1
4	22	5.3	0.3	67.0
4	23	1.4	0.3	68.3
4	24	5.9	0.0	70.3
4	25	9.2	0.0	72.9
4	26	9.8	0.0	75.6
4	27	5.9	1.3	77.6
4	28	7.0	4.6	73.8
4	29	3.7	0.0	75.4
4	30	5.9	0.0	77.4
5	1	9.2	0.0	81.5

overwinter precip.=135.9

Spring Start-up Value= 73.4

5	2	18.1	7.6	67.3	
5	3	7.0	0.0	71.0	
5	4	7.0	0.0	74.7	
5	5	6.4	2.0	78.2	
5	6	-1.9	0.3	80.3	
5	7	10.3	0.0	84.5	
5	8	3.1	0.0	88.4	
5	9	17.0	0.0	93.9	
5	10	22.6	0.0	100.3	
5	11	14.3	0.0	105.4	
5	12	11.4	0.0	109.9	
5	13	12.0	0.0	114.4	
5	14	12.6	0.0	119.1	
5	15	10.9	2.3	123.5	
5	16	9.2	0.0	127.5	
1	5	17	13.7	0.0	132.4
5	18	17.6	0.0	138.0	
5	19	15.3	3.6	138.4	
5	20	15.9	0.0	143.6	
5	21	18.1	0.0	149.3	
5	22	20.9	0.0	155.5	
5	23	22.6	0.0	161.9	
5	24	23.1	0.0	168.5	
5	25	15.3	1.8	173.7	
5	26	9.2	0.0	177.7	
5	27	12.6	0.0	182.4	
5	28	11.4	0.0	186.8	
5	29	18.7	0.0	192.6	
5	30	18.1	1.0	198.3	
5	31	13.1	4.6	194.9	
6	1	8.1	10.2	177.3	
6	2	8.7	1.3	182.3	

6	3	15.1	0.0	189.1
6	4	15.7	0.1	187.3
6	5	12.0	0.0	192.8
6	6	12.0	0.5	198.4
6	7	11.5	0.0	205.9
6	8	12.5	0.0	209.5
6	9	14.8	0.0	215.6
6	10	18.1	0.0	222.3
6	11	19.8	0.0	229.2
6	12	24.8	0.0	237.1
6	13	16.4	0.0	243.4
6	14	15.3	0.0	249.6
6	15	16.4	0.0	256.0
6	16	15.9	0.0	262.2
6	17	19.2	0.0	269.1
6	18	23.1	0.0	276.6
6	19	25.3	0.5	284.6
6	20	19.8	0.0	291.6
6	21	15.3	0.0	297.7
6	22	16.4	0.0	304.1
6	23	19.8	0.0	311.1
6	24	22.6	3.8	310.5
6	25	20.9	1.5	317.7
6	26	14.2	0.3	323.7
6	27	14.2	0.0	329.6
6	28	18.1	0.0	336.3
6	29	19.8	0.0	343.3
6	30	22.6	0.0	350.7
7	1	25.9	0.0	359.1
7	2	25.9	0.0	367.5
7	3	23.7	0.0	375.4
7	4	19.8	1.0	382.7
7	5	12.0	3.7	339.9
7	6	15.9	1.3	346.5
7	7	19.8	0.0	353.7
7	8	22.6	0.0	361.5
7	9	22.0	0.0	369.2
7	10	22.0	0.0	376.8
7	11	25.9	0.0	385.2
7	12	29.2	0.0	394.1
7	13	22.0	0.0	401.8
7	14	13.7	0.0	408.0
7	15	23.1	0.0	415.8
7	16	19.8	1.8	423.1
7	17	20.3	0.0	430.5
7	18	20.3	0.3	437.8
7	19	22.6	0.0	445.6
7	20	24.8	0.0	453.8
7	21	18.7	0.8	460.8
7	22	21.4	2.5	468.4
7	23	16.4	3.3	465.8
7	24	18.1	7.6	442.2
7	25	12.0	2.0	448.1
7	26	13.7	1.3	454.2
7	27	12.6	0.3	460.2
7	28	17.0	1.3	467.0
7	29	15.9	1.5	473.5
7	30	18.7	1.3	480.6
7	31	16.4	0.5	487.3
8	1	16.4	3.8	480.9
8	2	15.3	0.0	486.6
8	3	14.8	0.3	492.3
8	4	18.1	0.0	498.6
8	5	22.6	0.0	505.6
8	6	23.7	0.0	512.9
8	7	24.2	0.0	520.3
8	8	24.2	0.0	527.6
8	9	24.2	0.0	535.0
8	10	21.4	0.0	541.8
8	11	24.8	0.0	549.3
8	12	28.7	0.0	557.5
8	13	17.6	0.0	563.7
8	14	17.6	0.0	569.8
8	15	17.6	0.0	576.0
8	16	15.9	0.0	581.9
8	17	22.0	0.0	588.8
8	18	26.4	0.0	596.6
8	19	26.4	0.0	604.3

BANFF NATIONAL PARK DROUGHT CODE VALUES

CARRY-OVER VALUE: 4-dc

Station is Lake Louise; Overwinter Mean = 400 mm
Year = 1940

Table with 4 columns of numerical data for years 1 through 44. Values range from -0.8 to 15.2.

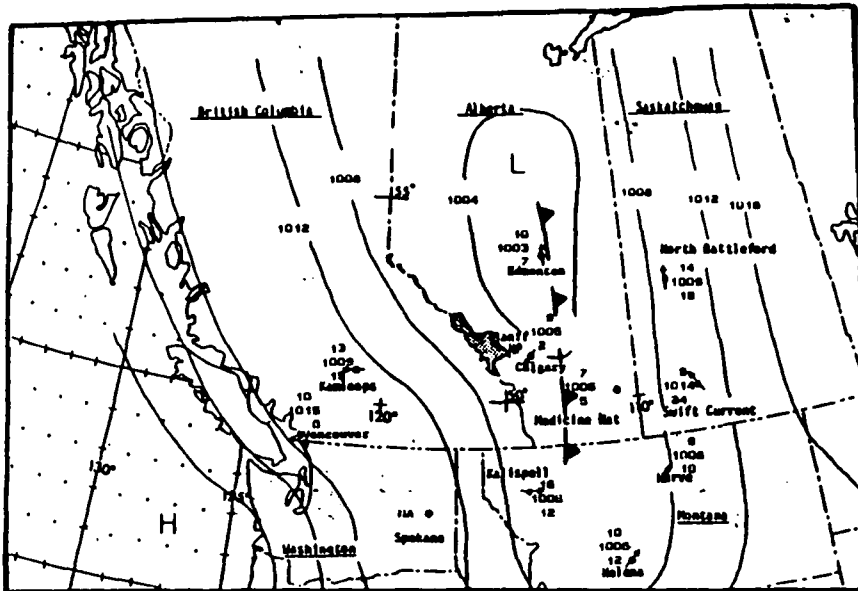
overwinter precip. = 259.6

Spring Start-up Value = 15.0

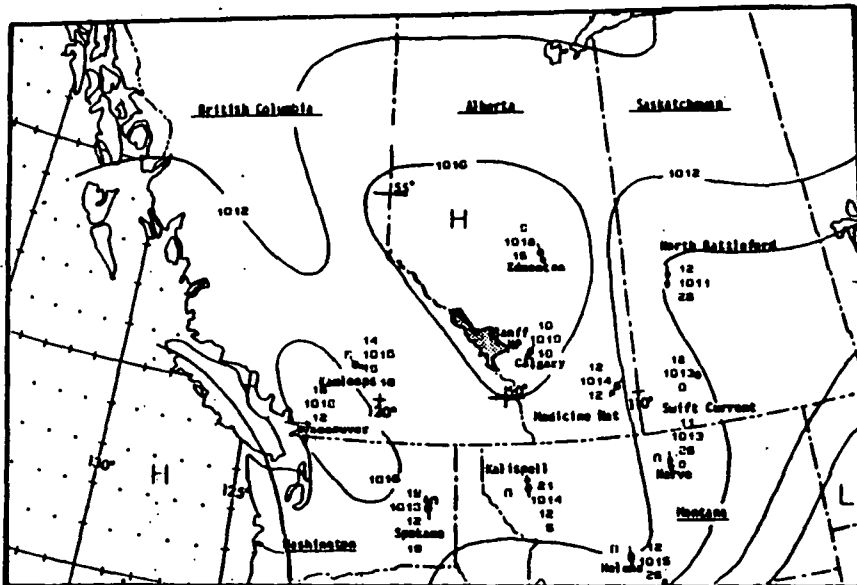
Table with 4 columns of numerical data for years 5 through 25. Values range from 8.1 to 19.2.

5	26	21.4	0.0	100.0
5	27	19.2	0.0	105.8
5	28	20.3	0.0	111.9
5	29	14.8	0.0	116.9
5	30	11.4	0.0	121.4

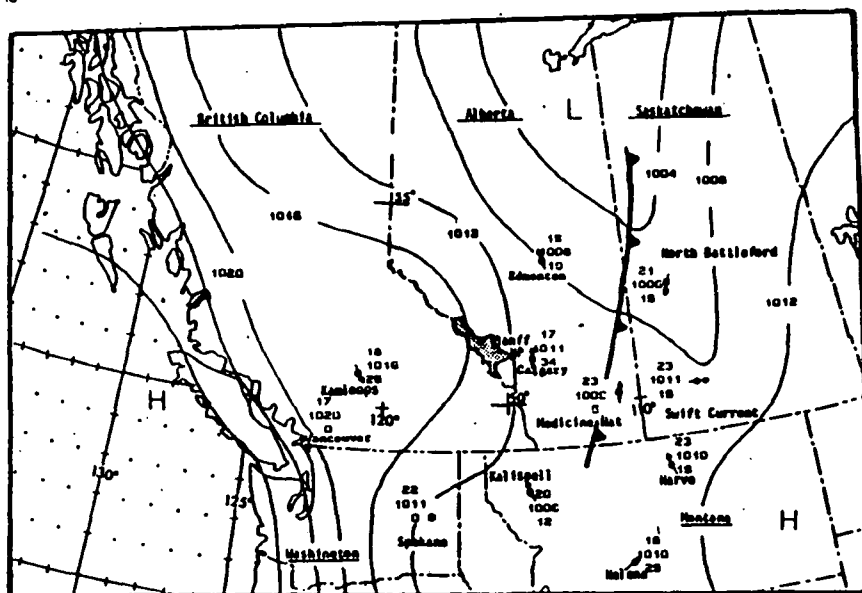
5	31	11.5	0.0	126.3
6	1	17.5	0.0	132.6
6	2	19.2	0.0	139.1
6	3	18.1	0.0	145.5
6	4	18.9	0.0	152.5
6	5	15.1	0.0	158.8
6	6	17.0	0.0	165.3
6	7	19.2	0.0	172.1
6	8	20.3	0.0	179.2
6	9	20.3	0.0	186.2
6	10	18.0	0.0	192.9
6	11	17.0	0.0	199.4
6	12	18.1	0.0	206.0
6	13	15.9	0.0	212.3
6	14	14.8	0.0	218.4
6	15	21.4	0.0	225.6
6	16	22.6	0.0	233.1
6	17	25.9	0.0	241.1
6	18	25.9	0.0	249.2
6	19	27.0	0.0	257.5
6	20	19.2	0.0	264.3
6	21	15.9	0.0	270.6
6	22	20.3	0.0	277.7
6	23	22.6	0.0	285.1
6	24	22.6	0.0	292.6
6	25	17.0	0.0	298.3
6	26	15.9	0.0	304.5
6	27	23.7	0.0	312.2
6	28	22.6	0.0	319.7
6	29	24.8	0.0	327.6
6	30	28.1	0.0	336.0
7	1	28.1	0.0	344.8
7	2	24.8	0.0	352.9
7	3	24.8	0.0	356.1
7	4	24.8	0.0	359.3
7	5	24.8	0.0	362.5
7	6	24.8	0.0	365.7
7	7	24.8	0.0	368.9



Map # 93: Surface Map:
May 25, 1940 - 8:00 p.m.

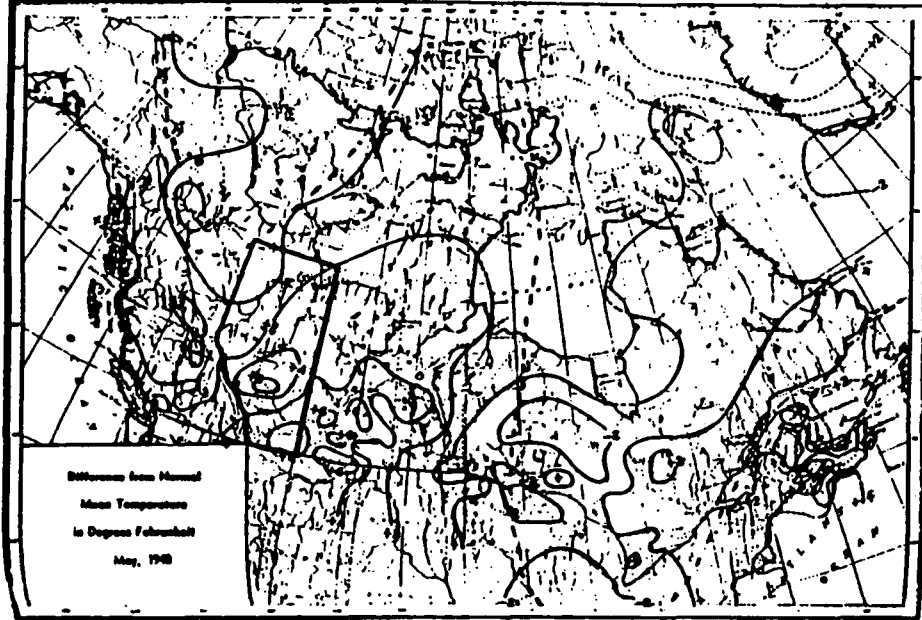


Map # 94: Surface Map:
June 1, 1940 - 8:00 p.m.

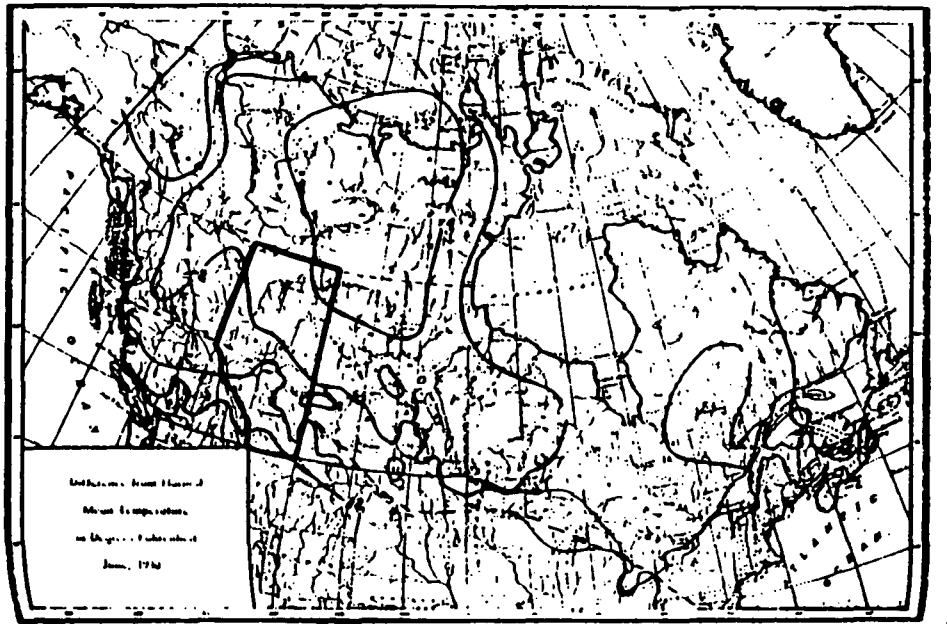


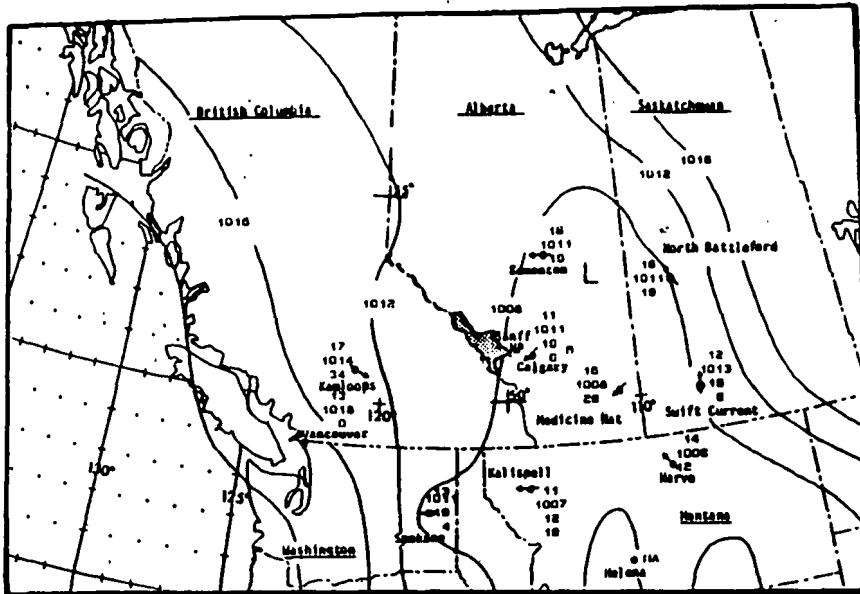
Map # 95: Surface Map:
June 4, 1940 - 8:00 p.m.

Map # 96-Departures from Normal Temperatures May, 1940

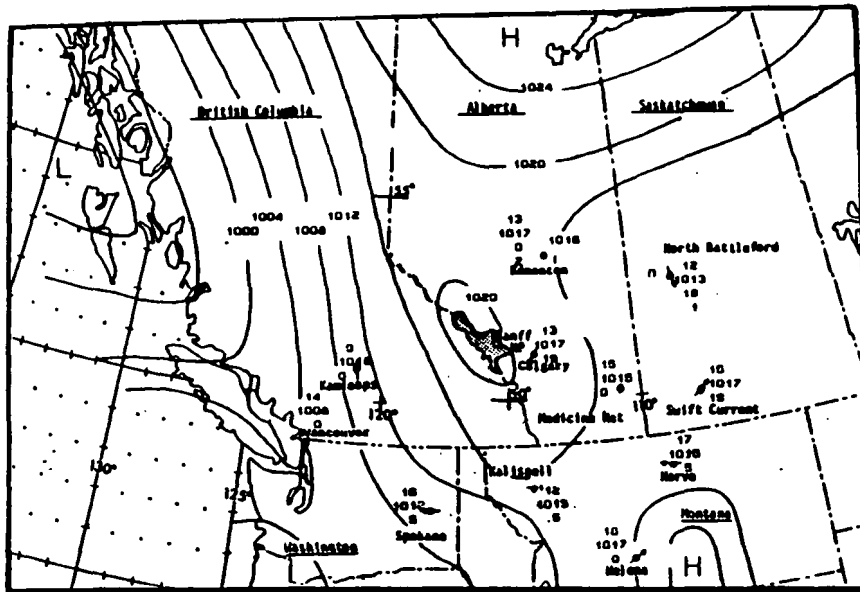


Map #97-Departures from Normal Temperatures June, 1940

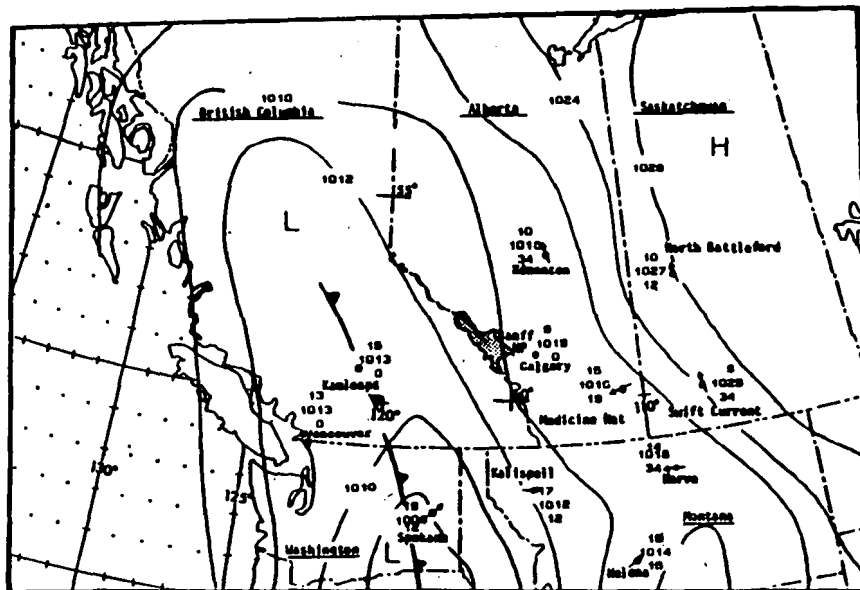




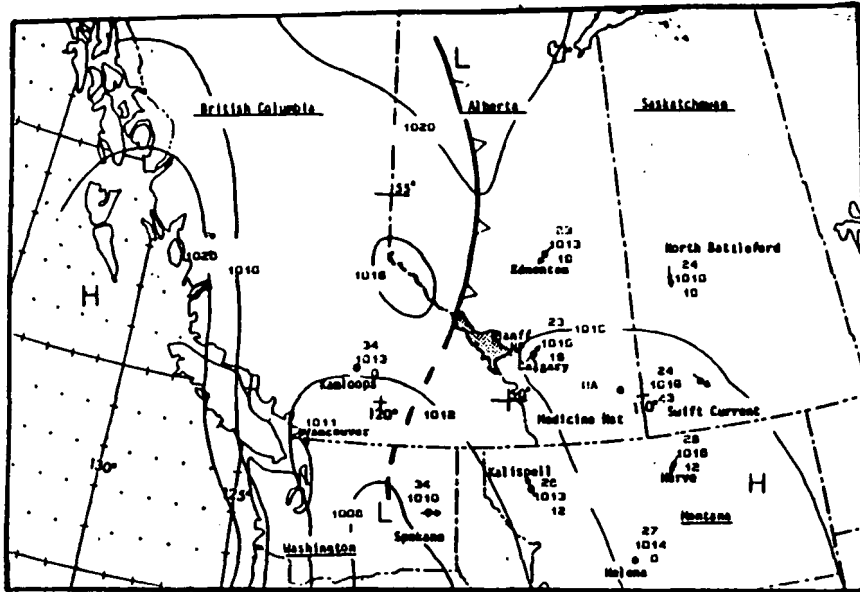
Map # 98: Surface Map:
June 7, 1940 - 8:00 p.m.



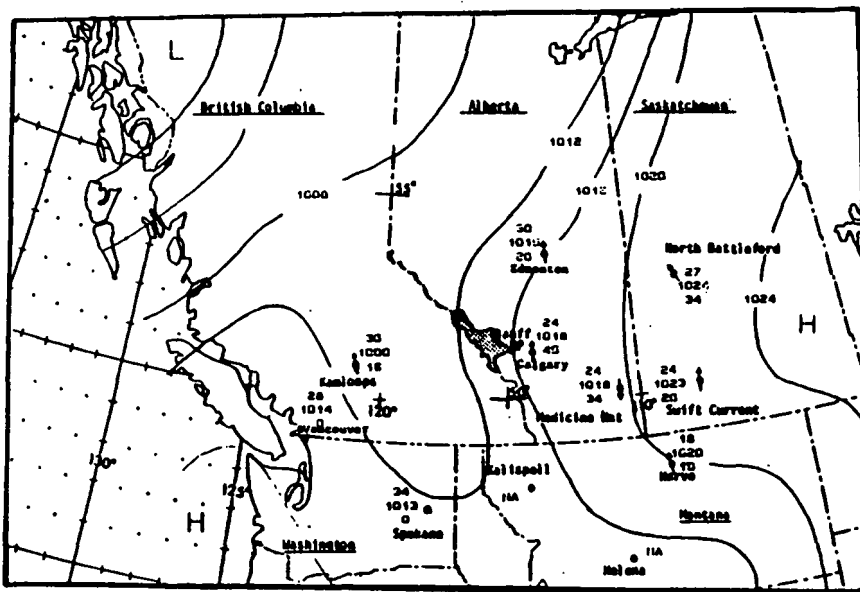
Map # 99: Surface Map:
June 12, 1940 - 8:00 p.m.



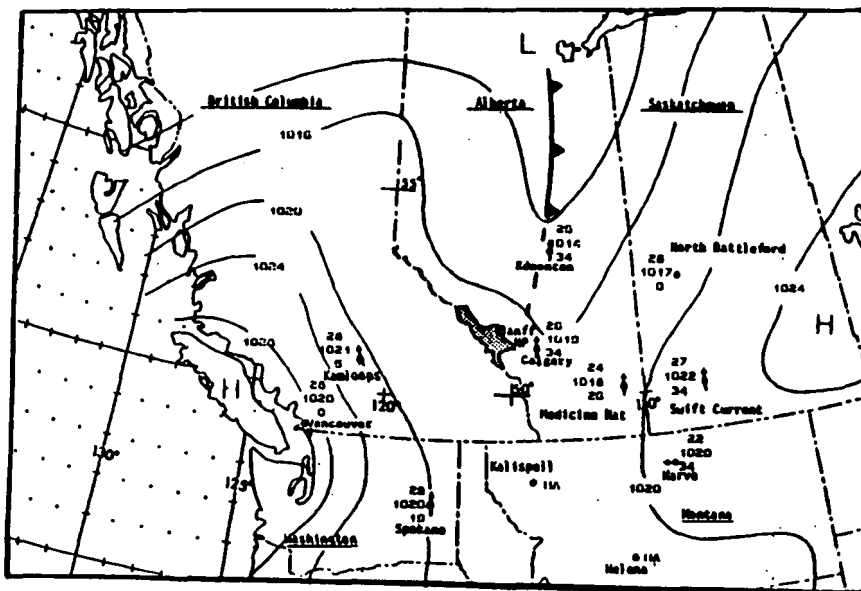
Map # 100: Surface Map:
June 19, 1940 - 8:00 a.m.



Map # 101: Surface Map:
June 24, 1940 - 8:00 p.m.

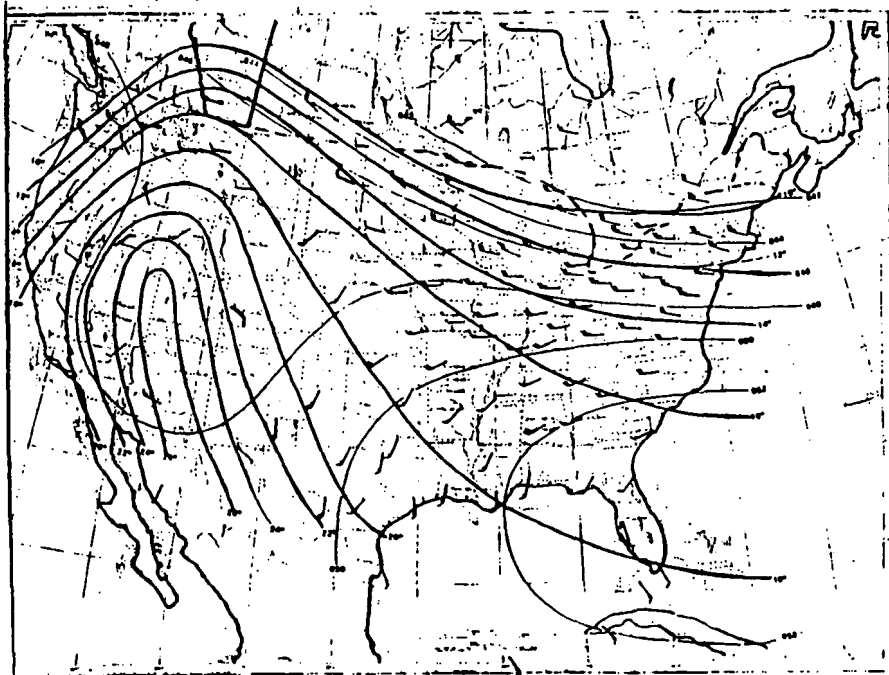


Map # 102: Surface Map:
July 1, 1940 - 8:00 p.m.

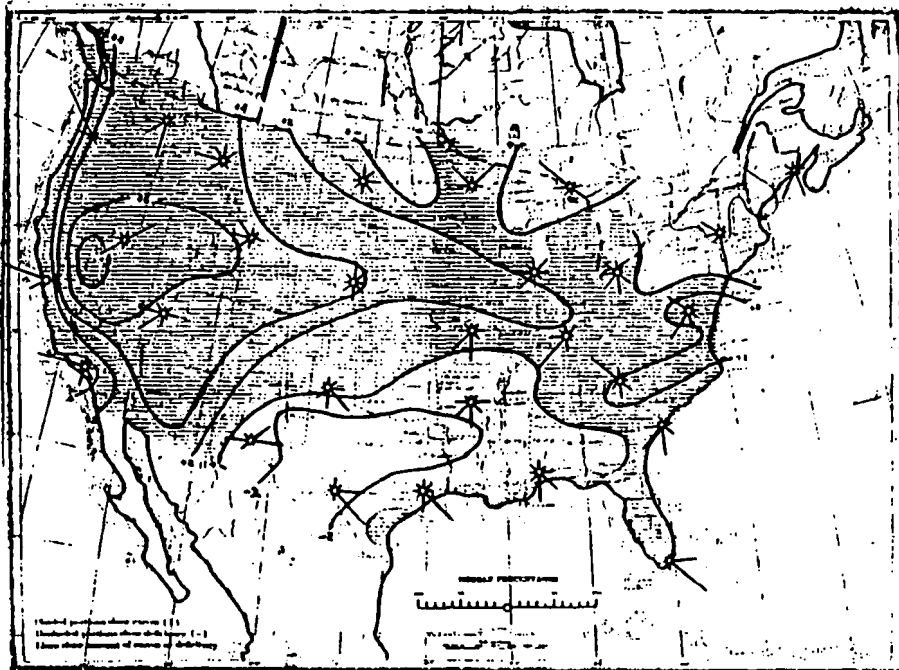


Map # 103: Surface Map:
July 2, 1940 - 2:00 p.m.

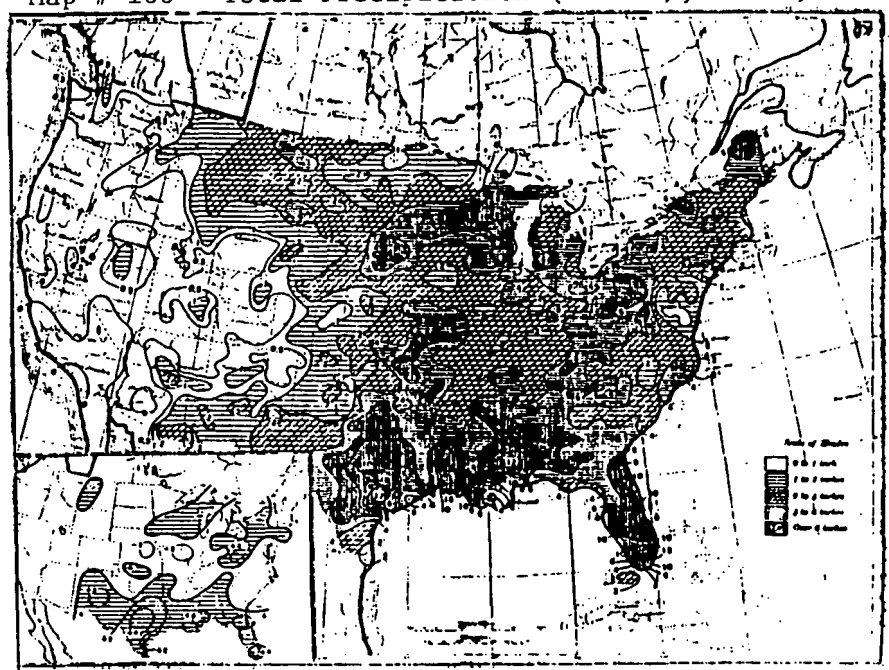
Map #104- Isobars (mb) of 1524m Isotherms ($^{\circ}\text{C}$) and resultant winds on June, 1940



Map #105- Departure ($^{\circ}\text{F}$) of the mean temperature from the Normal June, 1940

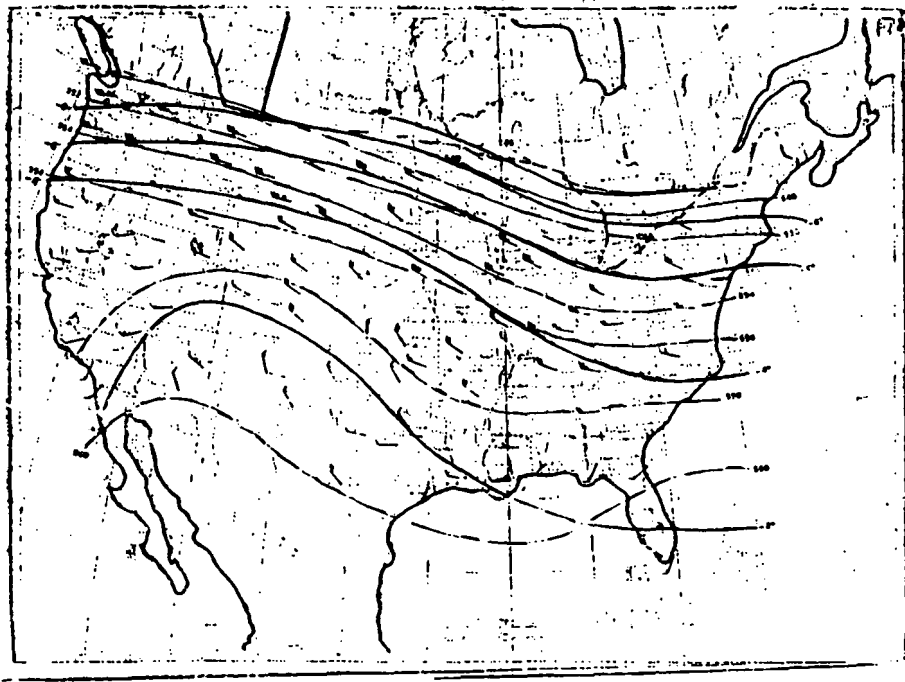


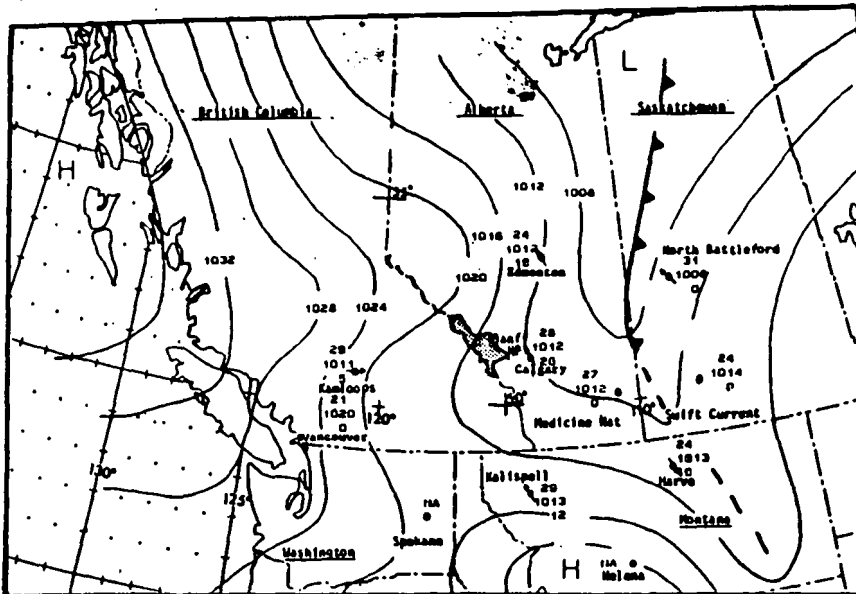
Map # 106 - Total Precipitation (inches), June, 1940



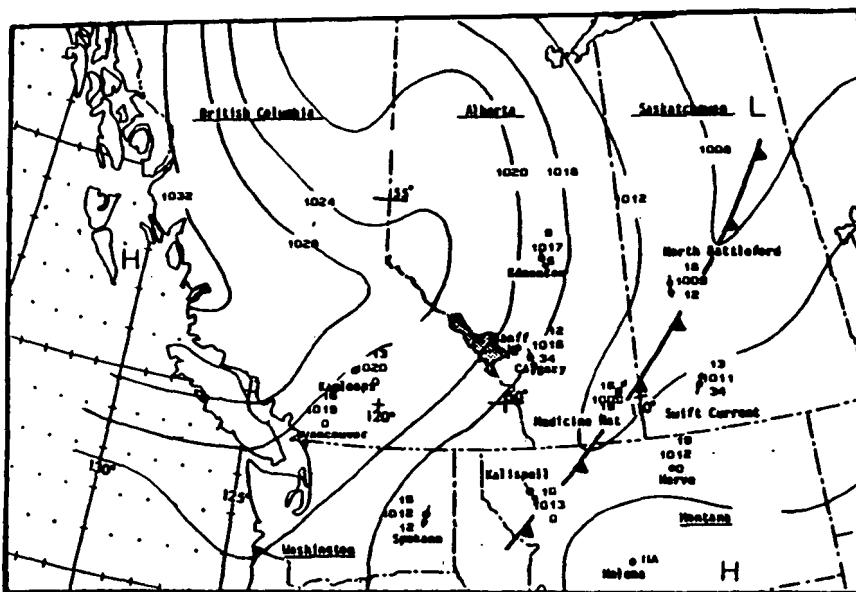
Inset - Departure of
Precipitation from Norm.

Map # 107 - Isobars (mb), Isotherms (°C) and Resultant Winds for 5000 m
June, 1940

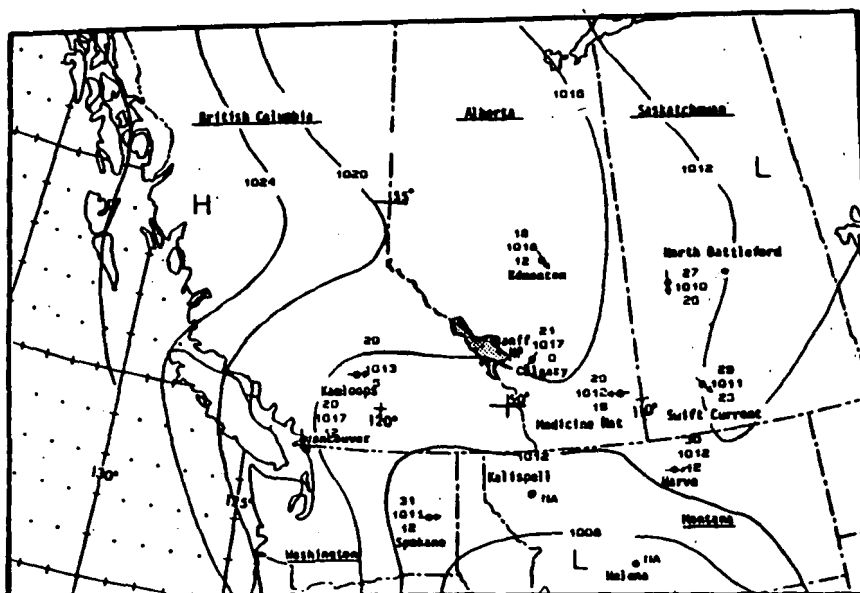




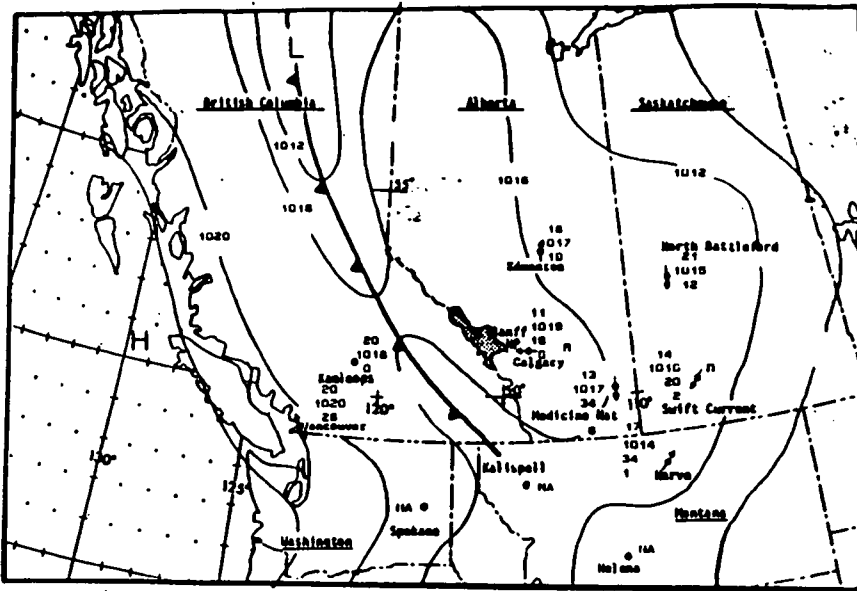
Map # 108 - Surface Map:
July 3, 1940 - 2:00 p.m.



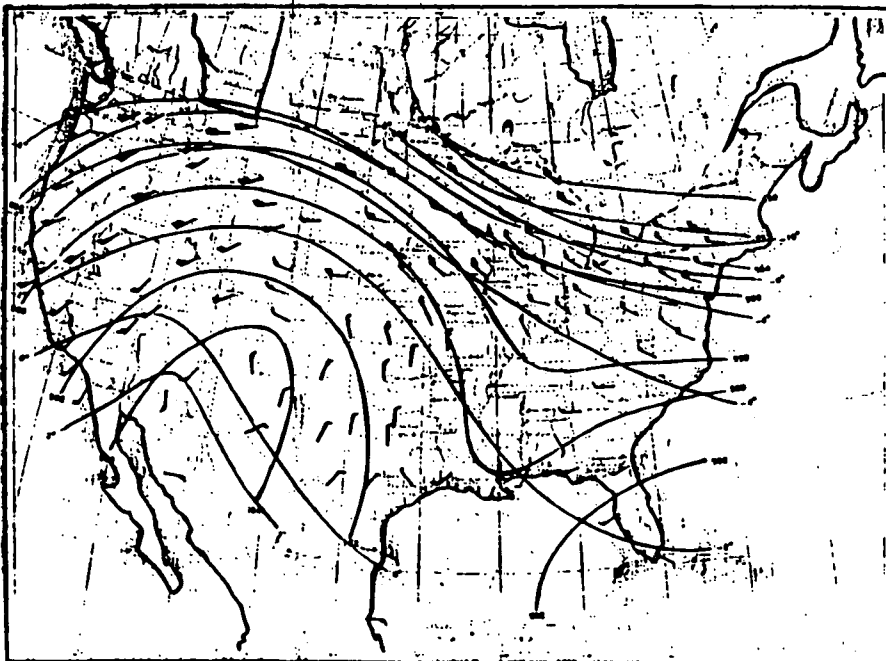
Map # 109 - Surface Map:
July 4, 1940 - 8:00 a.m.



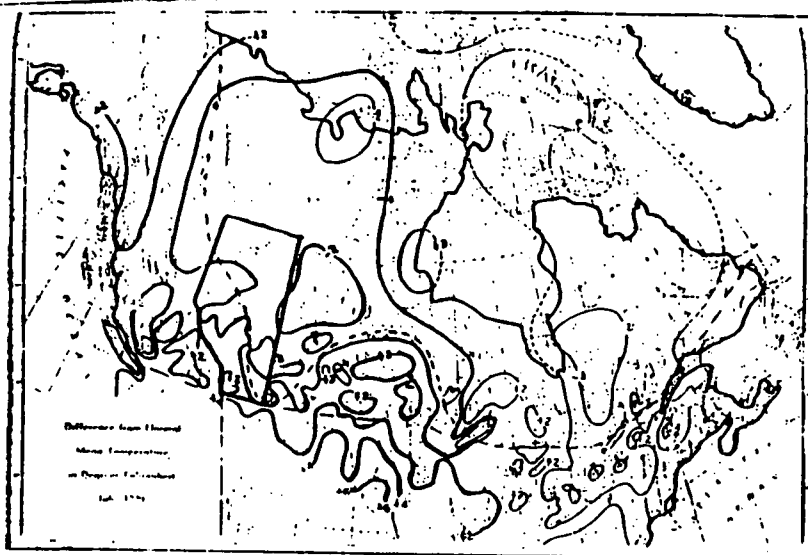
Map # 110 - Surface Map:
July 4, 1940 - 8:00 p.m.



Map # 111 - Surface Map:
July 5, 1940 - 8:00 p.m.



Map # 112 - Isobars (mb)
5000 m, July, 1940



Map # 113 -
Departures from normal
temperatures, July, 1940

tation was significantly below normal with December, and, in particular January being well below normal, the respective months received 63.6% and 17.3% of the norm. February, although being an above normal precipitation month (by 28%), had little effect on the overall winter precipitation trends. Low snowfall in winter, 69.6% of normal, would initiate a moisture deficit that would persist until May and then become worse.

Throughout March and April, precipitation, although being subnormal, was not significantly low, and the spring start-up drought-code had a value of 73.4 which was only 18 points above normal. Then, as spring came to an end, May precipitation dipped well below normal to a value of 44.6% of the mean. Banff received precipitation on 7 days during May, which was 5 days less than the standard, and only 1 major disturbance resulted in rain greater than 5 mm. In Lake Louise a 22 day stretch without rain was recorded and then, finally, on the 25th, a well defined low pressure system brought 12.5 mm of rain (see Map # 93). No rain was recorded in Banff as this system passed over. This is attributed to the fact that this trough extended into Alberta from the North West Territories and did not pass over the Great Divide. Although the cold trough affected weather in the front ranges, its westward limit fell short of Lake Louise. Precipitation in Lake Louise resulted from a moist maritime high lying over British Columbia and, as it met the cold trough air in Alberta, instability brought precipitation. This high did not extend over Banff, therefore no precipitation was recorded in the lower Bow Valley.

Monthly temperature deviation charts, Map # 96, indicate the occurrence of above normal temperatures throughout southern British Columbia and all of both Alberta and Saskatchewan. This phenomena is attributable to the probable occurrence of an upper blocking ridge preventing cyclonic disturbances from tracking over the region. As a result, temperatures and surface pressures were above normal and precipitation was below normal for the month of May throughout all of Alberta, as indicated by Table # 16. The approximate boundaries of such a high are marked by the dashed line on Map # 96.

In Banff June began with cool temperatures and rainy weather. Lake Louise, on the contrary, experienced much warmer temperatures and no rain. Map # 94

reveals the synoptic situation which brought about this abnormality. Upslope winds occurred as a result of the high over the Rockies and low over Montana. These circumstances resulted in orographic precipitation in the foothills and front ranges. Kananskis, Exshaw, Antracite and Banff all received precipitation in excess of 8 mm. These upslope conditions were associated with temperatures in the low teens. It appears that these upslope conditions did not persist as far as the Great Divide which was probably under the influence of a drier, warmer air mass located in British Columbia. Temperatures reached the high teens and no rainfall occurred. This system weakened on the 2nd but remained quasi-stationary, and temperatures remained as they were on the 1st. Upslope conditions still persisted but the air mass, being much drier, dropped little precipitation. As the British Columbia coastal high pushed inland on the 3rd, skies began to clear and temperatures began to rise. On the 4th a low pressure system in the North West Territories extended a trough in Alberta. The intrusion of the trough, and its confrontation with the maritime high in British Columbia, resulted in instability and precipitation throughout the Rockies on the 4th and 5th. Map # 95 illustrates this situation. This synoptic pattern weakened on the 5th and 6th. On the 7th a low over Montana, see Map # 98, resulted in upslope winds and again insignificant precipitation fell in Lake Louise and Banff. Temperatures then rose, as the Rockies were under the influence of high pressure, and by the 12th a high over the northern prairies brought clear skies and warm temperatures. A few millimeters of precipitation fell in both Lake Louise and Banff, as this high had a mild confrontation with a deep low after the British Columbia coast (see Map # 99). This system remained quasi-stationary and temperatures fell as the low began to dominate; 5.3 mm of rain fell at Lake Louise, Banff recorded no precipitation.

Temperatures began to rise on the 15th and, by the 19th, a low over British Columbia and a high on the prairies had brought a strong southerly flow. Temperatures reached 25°C in Banff and 27°C in Lake Louise. Map # 100 depicts this situation. This low also brought some precipitation to Lake Louise and Banff. As it tracked east, temperatures fell. Barometric pressures began to rise on the 22nd, along with the temperatures. By the 24th, see Map # 101,

a trough in the North West Territories extended a weak trough cold front over the Rockies. Temperatures moderated as 4.3 mm of precipitation was recorded in Banff on the 24th and 25th. Lake Louise received rain on the 25th and 26th, as a low over Washington brought rain to the southern Rockies. Temperatures fell on the 25th and 26th, as Banff and Lake Louise were under a northerly flow. By the 28th temperatures were rising as a high lay over the Rockies. This high weakened before amalgamating with a high over the Yukon on the 29th. As this high intensified, it slipped down over Alberta and Saskatchewan, and by the 30th provided a hot dry easterly flow from southern Saskatchewan.

June had not been a hot month for Banff and monthly high temperatures were about average for most of central Alberta. Lake Louise, on the other hand, had been abnormally warm with the average daily temperature being 4.90° above normal (see Table #8). Actually, Lake Louise had been the hot spot for the following drainages: North Saskatchewan, Red Deer, Bow, Athabasca and the Peace Rivers. Precipitation had also been below normal; Banff received 40.6% of the normal and Lake Louise received 23.5% of its norm. Precipitation deficits occurred throughout the entire province but Lake Louise took top honours for being driest for all the drainages mentioned above.

The occurrence of such widespread moisture deficits is almost certainly attributable to the occurrence of an upper ridge. Maps # 104-107 from the United States Weather Bureau illustrates this ridge and moisture deficits caused by its persistence. Map # 104, Isobar at 1524 m, illustrates the strength of this ridge in the lower atmosphere and reveals wind direction primarily to the southeast on the western ridge front in Alberta. Looking at Maps 105 & 106, temperature and precipitation reveals that under this ridge temperatures were extreme (26°C at 1524 m) over the ridge peak of Nevada and Utah, and that precipitation was at a deficit over the entire ridge area. It is important to note that this ridge, although influencing Canada's weather, did not have the significance it did in the States. This is revealed by examining Map # 107 Isobars at 5000 m. Although a slight ridge appeared over the northern States and southern Canada, isobars lay parallel to the border, and the flow was primarily from the west. As a result, temperatures were not extreme over much

of southern Alberta but the persistence of the ridge at the 1524-5000 m level resulted in a moisture deficit throughout southern British Columbia and Alberta. Map # 97, Deviations from Temperatures, reveals the effect of this ridge on British Columbia and Alberta. The dashed line deliniates the boundaries or ridge influence. Note that the peak of the influence occurred on the British Columbia coast and decreased through Alberta towards Medicine Hat.

Synoptic Condition Immediately Preceding and
During the Saskatchewan Crossing Fire

On July 1st high temperatures prevailed as the Saskatchewan high of June 20 tracked south, and a high dry southerly flow persisted (see Map # 102). Again, Lake Louise was warmer than Banff with a temperature of 28°C. By the 2nd of July, Map # 103, a weak trough extended into Alberta from the North West Territories and with it came a weak cold front. Daily high temperatures fell at Lake Louise to 24.8°C but remained stable at Banff at 25.9°C. No rain was recorded at either station.

On July 3rd the low which had intruded into Alberta deepened and intensified. As shown on Map # 108, a well developed cold front extended over Banff National Park. As a result of past hot weather, instability created by the cold front was great and the ignition source of the Saskatchewan Crossing Fire was probably dry lightning. Winds were most likely from the southwest and strong, but probably fluctuated in direction erratically. Fanned by strong winds, the fire probably crowned immediately and burned northeastward. As the July 5th Crag and Canyon described, "The blaze broke out near Glacier Lake Wednesday morning, and travelled with amazing speed down the Howse River to the North Saskatchewan, jumping the new highway at Mile 52 Wednesday afternoon. Driven by a high wind, the blaze roared over the slopes of Mount Wilson and followed the new road for eight miles".

As the low tracked eastward in the evening, the cold front swung south-east of the fire and winds remained strong from the south-southwest. This cold sector of this low, although moderating temperatures, only dropped temperatures in Jasper to 22.8°C on the 3rd. The cold front passed over Banff during the night, and the temperatures fell from 28.3°C to 22.8°C along with a scant 1 mm of precipitation on the 4th, (see Map # 109).

Even though the fire was now in the cold sector of the low, fire activity increased throughout the day. Undoubtedly, the fire, after burning with such intensity on the 3rd, still had some momentum and, without a good rain, would

burn as it pleased. According to reports, the fire jumped the North Saskatchewan in the afternoon after sweeping around the slopes of Mount Wilson (Crag and Canyon). This burn-direction indicates that winds were changing from the southwest to the west. Intensity during this run was still severe. "Thirty fire fighters were temporarily trapped between two spot fires and the main fire" (Crag and Canyon). Fire intensity began to decrease into the evening and the first signs of possible cessation were eminent.

Synoptic Situation at the End of the Saskatchewan Crossing Fire

By the evening of the 4th a cyclonic disturbance over Montana (see Map # 110), brought upslope winds to Calgary. The high over the coast of British Columbia had moved inland over northern B.C. and the previous day's low lay over Saskatchewan. This situation, and the confrontation of the B.C. high and Montana low, intensified upslope winds from the northeast and precipitation doused the fire. By the afternoon of the 5th, a weak high pressure cell lay over the Rockies and a low in the Yukon extended a weak front over the Rockies. Winds remained upslope and temperatures were a cool 10°C in Calgary. By that evening, the trough had developed into a weak low and, a cold front beginning in this low, extended through B.C. to the low over Montana (see Map # 112). This cold front appeared to track westward as the high of the previous day deteriorated. Temperatures fell to a low 12.0°C in Banff and 13.7 mm of precipitation was recorded. Lake Louise weather is unknown. It appears that due to the ignition of the fire, Wardens, who were probably the meteorologists at that time, were called out to the fire, and no one replaced them throughout the rest of the month. Rainfall definitely occurred at the fire on the evening of the 4th and through the 5th. (Crag and Canyon). This rain brought about the cessation of the fire and no major spread was reported after the 5th.

Although the upper ridge of the last month had built somewhat throughout July, as shown by the 5000 m Isobar Chart (Map # 112), its affect on Canada appeared to be minimal. Most of southern British Columbia had southwestern Alberta experienced above normal temperatures throughout the month, as shown by Map # 113. The dashed line on this map indicates the area which was affected

by the United States upper ridge. Precipitation for the month was almost normal but fell after the fire had run its course.

Vermilion Pass Fire July 9-15, 1968

The Vermilion Pass fire ignited from a dry lightning strike on July 9, 1968 at approximately 15:30 hr. The fire spread rapidly and was 81 ha in size by 22:00 hr.. For the next two days it burned out of control, despite intensive fire control efforts. On the 12th of July, firespread ceased, as a result of cool damp weather in the Rockies. On the 15th of July the fire was under control but mop-up of spot fires occurred until early August (Harris 1976). Total fire size was 2430 ha (Harris 1976), making it the largest fire since 1940.

The synoptic analysis of this fire season is far superior to the synoptic investigations of pre-1968 fire season. This is solely a result of improved fire behavior documentation and drastically improved atmospheric measurement techniques. This analysis will include both surface map and 500 mb chart analysis. The synoptic events which led to the occurrence of extreme fire danger and behavior of the 1968 burn are unique. Similar synoptic situations will always be the most extreme fire weather conditions occurring in Banff National Park.

Synoptic Situation in Months Preceding Fire

The late winter, spring and early summer of 1968 was not particularly dry with total precipitation for January 1 - August 3, 1968 being 95.5% of the normal. Table 9 and Graph # 8 illustrate precipitation trends throughout 1968. In order to pin-point the cause for a start-up drought-code of 174.6 points above the normal of 55.3, it became necessary to scrutinize early winter precipitation trends. The precipitation deficits which caused the high start-up drought-code occurred in November and December of 1967, when 23.3% and 64.9% of the normal Banff monthly precipitation was recorded. Map # 114 from the February 1969 Weatherwise issue depicts the circulation which resulted in low precipitation in December 1967, January and February 1968. The 700 mb average for winter 1967-68 was characterized by blocking, as seen by the

Table : Monthly Precipitation 1968 and Avg. Monthly Precip. 51-80

	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May.</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Total</u>
1968	3.18	0.53	4.04	3.23	5.13	4.75	4.60	4.90	30.66
Avg. 51-80	2.82	2.78	2.09	3.76	5.18	6.13	4.24	4.89	32.18
% of Norm.	83.0	19.0	193.0	85.0	99.0	77.0	108.0	100.0	95.53

Note: Nov. 67 .74 cm = 23.3%
Dec. 67 2.46 cm = 64.9%

Graph 8: Precipitation Trends 1968

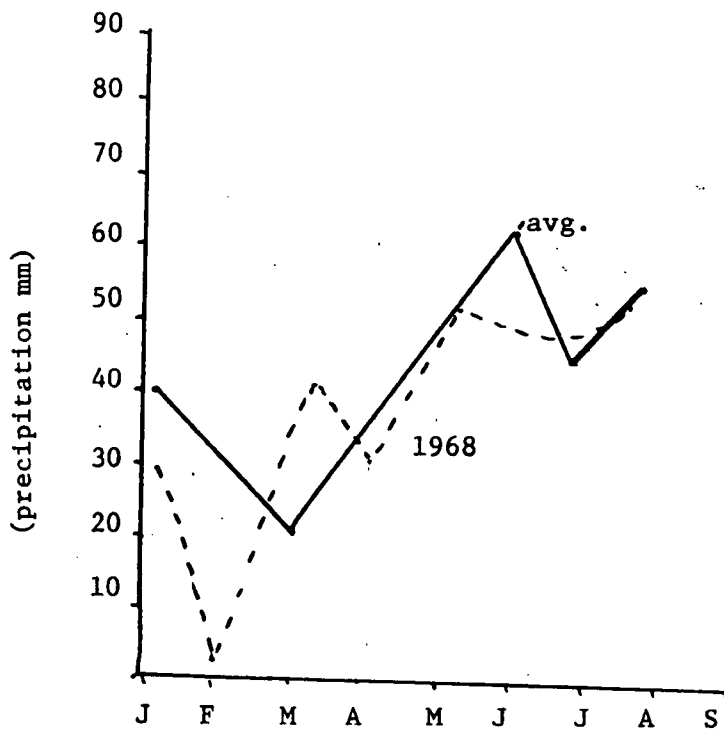


Table 19

 *****BANFF NATIONAL PARK DROUGHT CODE VALUES*

CARRY-OVER VALUE: 317-dc

Station is Banff; Overwinter Mean = 179mm
Year = 1968

4	1	-6.5	3.0	312.4
4	2	-5.2	1.5	312.9
4	3	3.7	0.0	314.5
4	4	4.2	0.0	316.2
4	5	2.6	0.0	317.8
4	6	0.9	0.0	318.7
4	7	1.4	0.0	320.0
4	8	3.1	0.0	321.5
4	9	7.6	0.0	323.8
4	10	9.2	0.0	326.4
4	11	2.6	1.4	292.9
4	12	-5.2	1.3	293.4
4	13	-2.4	0.0	293.9
4	14	0.9	0.5	295.0
4	15	-0.2	1.5	295.9
4	16	1.4	0.0	297.1
4	17	3.1	0.0	298.6
4	18	4.2	0.0	300.4
4	19	-0.2	2.5	301.3
4	20	0.3	1.3	302.3
4	21	2.0	0.0	303.6
4	22	5.3	0.0	305.5
4	23	5.9	0.8	307.5
4	24	3.7	0.0	309.1
4	25	5.9	0.0	311.2
4	26	6.4	0.5	313.3
4	27	9.2	0.0	315.9
4	28	13.1	0.0	319.2

overwinter precip. = 91.4

Spring Start-up Value = 229.9

4	29	15.9	0.0	233.7	
4	30	10.9	7.9	218.4	
5	1	4.2	0.3	221.5	
5	2	7.0	0.0	225.2	
5	3	10.3	0.0	229.4	
5	4	13.1	3.8	227.7	
5	5	2.0	4.3	222.5	
5	6	5.7	0.0	225.6	
5	7	5.9	0.0	229.1	
5	8	9.2	0.0	233.1	
5	9	10.3	0.0	237.4	
5	10	12.6	0.0	242.1	
5	11	14.2	0.0	247.0	
5	12	15.9	0.0	252.3	
5	13	8.7	4.3	247.8	
5	14	0.3	1.2	222.0	
5	15	8.1	0.0	225.8	
5	16	14.8	0.0	230.9	
1	5	17	12.0	0.0	235.5
5	18	15.3	0.0	240.6	
5	19	17.0	0.0	246.1	
5	20	19.2	0.0	251.9	
5	21	14.8	0.0	237.0	
5	22	8.7	9.4	237.2	

5	23	10.9	0.5	241.6
5	24	14.2	0.0	246.6
5	25	13.7	0.0	251.4
5	26	12.6	2.5	256.1
5	27	11.4	0.0	260.6
5	28	12.0	0.8	265.1
5	29	10.3	1.3	269.7
5	30	8.7	13.0	238.2
5	31	10.9	0.0	242.6
6	1	12.6	0.0	248.2
6	2	12.0	8.4	233.5
6	3	10.9	0.0	238.8
6	4	12.0	0.0	244.4
6	5	15.3	0.0	250.5
6	6	13.7	0.8	256.4
6	7	10.3	3.8	254.7
6	8	14.2	4.8	250.7
6	9	17.0	0.0	257.1
6	10	16.4	0.0	263.5
6	11	16.4	0.0	269.9
6	12	9.3	3.8	267.8
6	13	9.3	4.6	263.3
6	14	8.7	1.0	263.3
6	15	12.0	0.3	273.8
6	16	14.2	0.3	279.8
6	17	14.3	0.0	285.9
6	18	13.7	0.0	292.6
6	19	15.3	0.8	298.8
6	20	11.4	0.5	304.2
6	21	15.3	0.0	310.4
6	22	14.2	0.3	316.4
6	23	11.4	5.8	306.7
6	24	18.7	0.0	313.5
6	25	21.4	0.0	320.7
6	26	18.7	2.5	327.5
6	27	14.2	0.3	333.5
6	28	10.9	0.0	333.8
6	29	8.1	6.1	326.7
6	30	9.2	3.0	326.3
7	1	19.2	0.0	333.5
7	2	23.1	0.0	341.3
7	3	24.9	0.0	349.5
7	4	26.4	0.0	358.0
7	5	27.0	0.0	366.5
7	6	27.0	0.0	375.1
7	7	22.0	0.0	382.8
7	8	24.2	0.0	390.8
7	9	27.0	0.0	399.4
7	10	23.7	0.0	407.3
7	11	23.7	0.0	415.3
7	12	19.2	3.6	413.0
7	13	14.9	0.0	419.4
7	14	14.8	3.1	396.3
7	15	13.7	1.5	402.4
7	16	14.2	3.0	402.2
7	17	18.1	0.0	409.1
7	18	14.9	1.0	415.5
7	19	13.1	6.1	401.9
7	20	12.6	6.6	385.9
7	21	14.3	3.3	384.7
7	22	15.3	0.3	391.2
7	23	13.1	2.4	352.6
7	24	13.7	0.0	359.7
7	25	20.3	0.0	367.0
7	26	19.2	0.0	374.2
7	27	25.3	0.0	382.5
7	28	26.4	0.0	390.9
7	29	19.2	0.0	398.1
7	30	15.9	0.0	404.6
7	31	22.0	0.0	412.3
8	1	23.7	0.0	419.6
8	2	23.7	0.0	426.8
8	3	23.7	0.0	434.1
8	4	13.7	2.9	401.9
8	5	20.3	4.1	397.3
8	6	9.2	0.0	401.9
8	7	14.8	0.0	407.6
8	8	10.3	2.5	417.5
8	9	15.9	0.0	413.3

- Table 20.

 *****BANFF NATIONAL PARK DROUGHT CODE VALUES*****

CARRY-OVER VALUE: 0-dc

Station is Lake Louise; Overwinter Mean = 162mm.
 Year = 1968.

4	1	-3.6	0.0	0.4
4	2	-3.0	0.0	0.9
4	3	2.6	0.0	2.3
4	4	2.0	0.0	3.6
4	5	1.4	2.5	4.8
4	6	0.3	0.0	5.9
4	7	2.6	0.0	7.3
4	8	-2.0	0.0	8.6
4	9	3.1	0.0	10.1
4	10	5.9	0.0	12.1
4	11	-3.0	10.2	0.4
4	12	-6.9	0.0	0.9
4	13	-1.9	0.0	1.5
4	14	-0.8	0.0	2.3
4	15	0.8	0.0	3.1
4	16	0.3	0.0	4.1
4	17	1.4	0.0	5.3
4	18	2.0	0.0	6.7
4	19	1.9	0.0	0.6
4	20	-0.8	0.0	1.4
4	21	2.0	5.0	1.3
4	22	5.3	0.0	3.2
4	23	2.0	0.0	4.5
4	24	2.0	0.0	5.9
4	25	2.6	0.0	7.3
4	26	4.8	5.0	3.2
4	27	5.9	0.0	5.2
4	28	12.0	0.0	8.3
4	29	12.6	0.0	11.5

overwinter precip.=191.8

Spring Start-up Value= 52.8

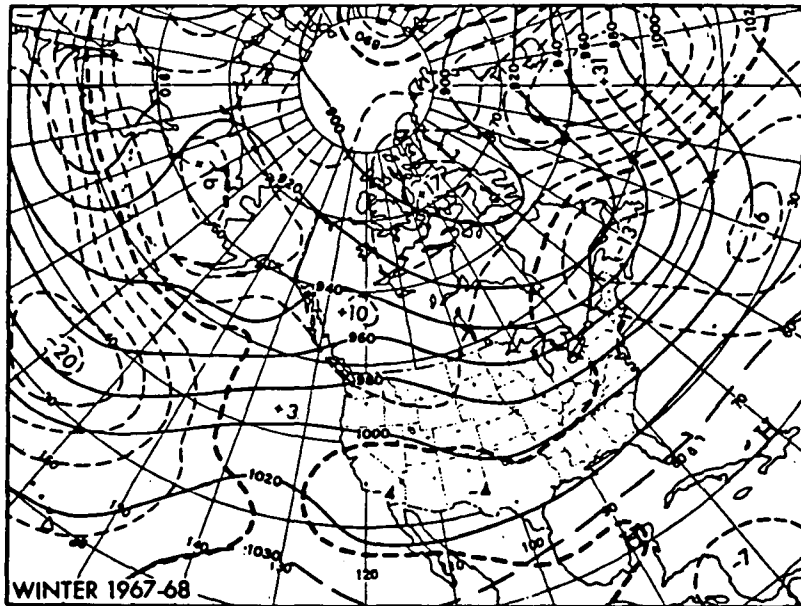
5	30	13.1	0.0	56.1
5	1	4.8	0.0	59.3
5	2	4.2	0.0	62.5
5	3	9.2	0.0	66.6
5	4	5.3	5.0	63.1
5	5	3.7	5.0	59.4
5	6	4.8	0.0	62.7
5	7	5.9	0.0	66.1
5	8	8.1	0.0	70.0
5	9	8.1	0.0	73.8
5	10	11.4	0.0	78.3
5	11	13.1	0.0	83.1
5	12	12.6	0.0	87.7
5	13	5.9	5.0	84.0
5	14	2.0	2.5	86.8
5	15	7.6	0.0	90.5
5	16	12.6	0.0	95.2
5	17	11.4	0.0	99.7
5	18	14.8	0.0	104.7
5	19	17.0	0.0	110.2
5	20	18.7	0.0	116.0
5	21	13.7	1.3	120.8
5	22	9.8	5.3	116.8
5	23	11.4	0.0	121.2
5	24	12.6	0.0	125.9
5	25	11.4	0.0	130.3
5	26	11.4	0.0	134.8

5	27	9.2	4.3	132.6
5	28	9.2	0.0	136.6
5	29	8.7	0.0	140.6
5	30	7.6	3.0	141.0

5	31	11.4	0.0	145.4
6	1	12.0	0.0	140.4
6	2	9.9	0.0	126.6
6	3	9.2	0.0	131.7
6	4	11.4	0.0	137.1
6	5	14.8	0.0	143.2
6	6	13.7	0.0	149.1
6	7	8.7	0.0	154.0
6	8	13.1	0.0	159.8
6	9	17.0	0.3	162.7
6	10	13.7	0.0	168.6
6	11	9.2	1.0	152.6
6	12	9.8	0.0	157.8
6	13	10.3	0.4	156.4
6	14	9.8	0.0	161.5
6	15	10.3	0.1	166.8
6	16	12.0	0.0	172.3
6	17	12.6	0.0	178.0
6	18	17.6	1.1	184.6
6	19	7.0	4.4	182.6
6	20	8.7	0.0	187.6
6	21	13.1	0.0	193.4
6	22	13.1	0.4	191.9
6	23	12.6	0.0	197.5
6	24	17.6	0.0	204.0
6	25	19.8	0.0	211.0
6	26	15.3	0.0	217.1
6	27	12.6	0.3	217.9
6	28	8.7	0.3	217.0
6	29	7.6	0.8	221.8
6	30	8.8	0.0	224.7
7	1	19.8	0.0	232.0
7	2	20.9	0.0	239.4
7	3	23.1	0.0	247.3
7	4	28.1	0.0	256.1
7	5	25.3	0.0	264.3
7	6	26.4	0.0	272.8
7	7	23.7	0.0	280.8
7	8	25.3	0.0	289.0
7	9	24.8	0.0	297.2
7	10	18.1	0.0	304.1
7	11	23.1	0.0	312.0
7	12	13.7	0.3	311.9
7	13	13.7	0.0	318.1
7	14	12.6	0.8	324.1
7	15	12.6	0.8	318.2
7	16	13.1	0.8	324.3
7	17	17.0	0.0	331.0
7	18	10.3	0.0	336.6
7	19	17.0	0.4	321.7

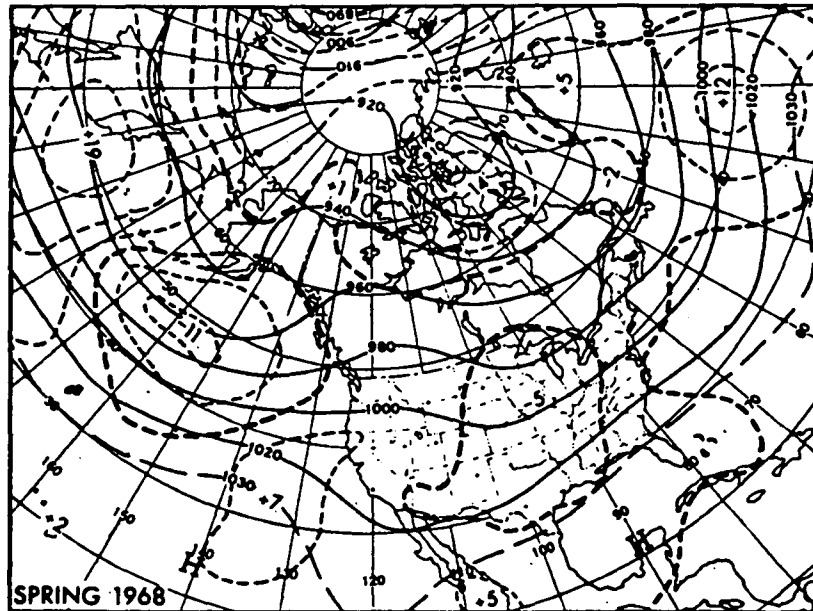
Map # 114 - Mean 700 mb contours and departures from Average, Winter 1968

Mean 700mb contours (solid) and departures from normal (dashed) (both in tens of feet) for winter (Dec. 1967, Jan. and Feb. 1968).

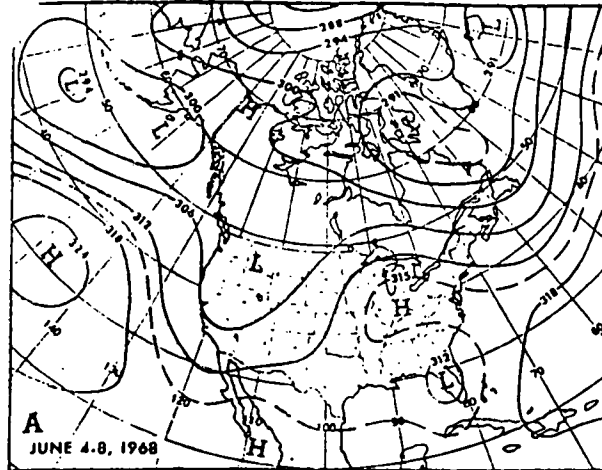


Map # 115 - Mean 700 mb contours and departures from Average, Spring 1968

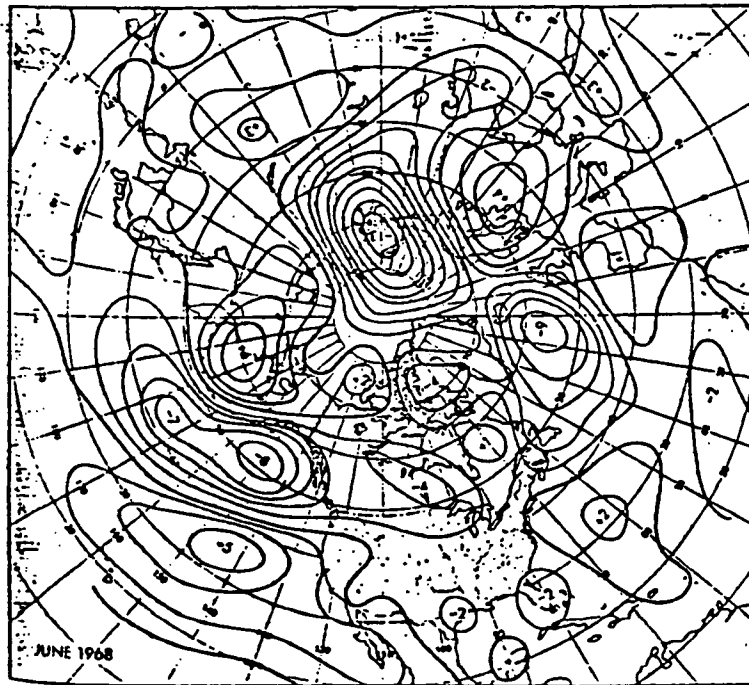
Mean 700mb contours (solid) and departures from normal (dashed) (both in tens of feet) for spring (Mar., Apr., May) 1968.



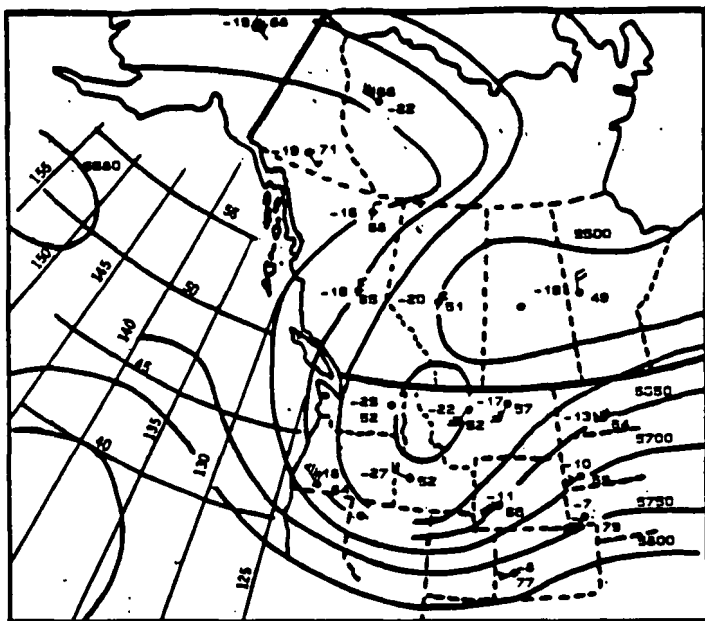
Map # 116 - 700 mb contours for June 4 - 8, 1968



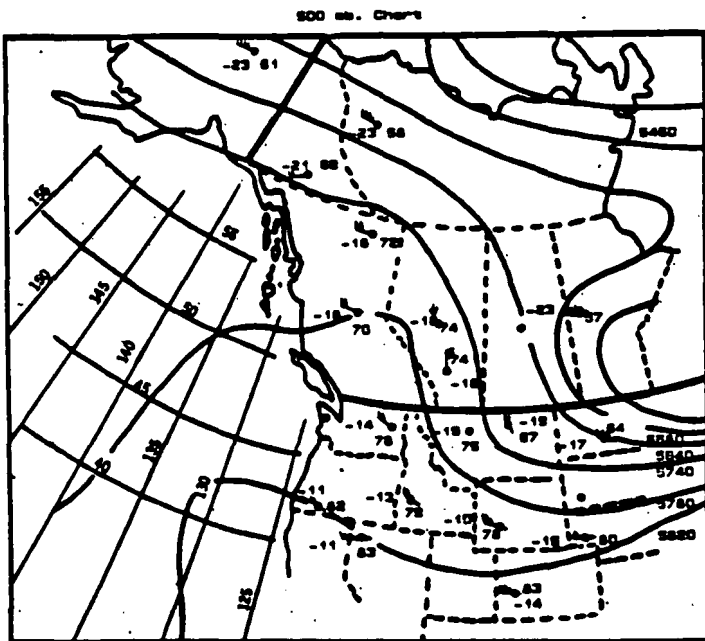
Map # 117 - Departure from normal 700 mb height for June, 1968



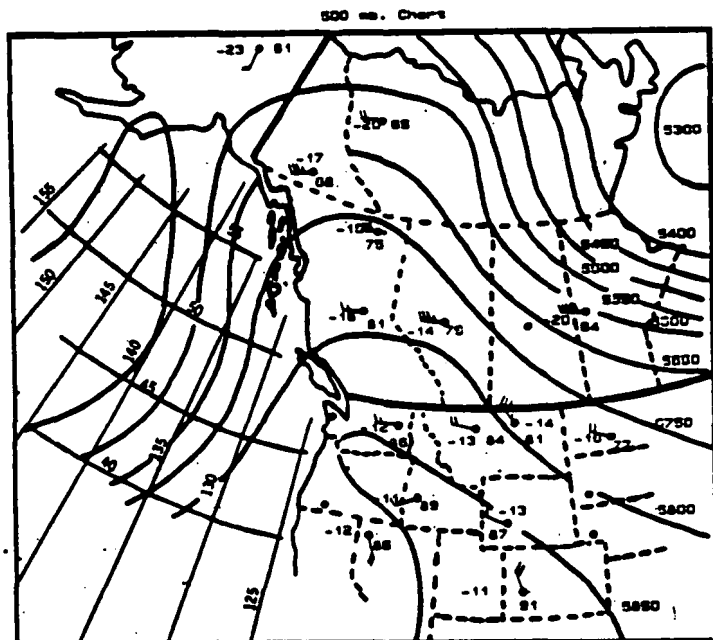
-Departure from normal of 700-mb. height (decameters)



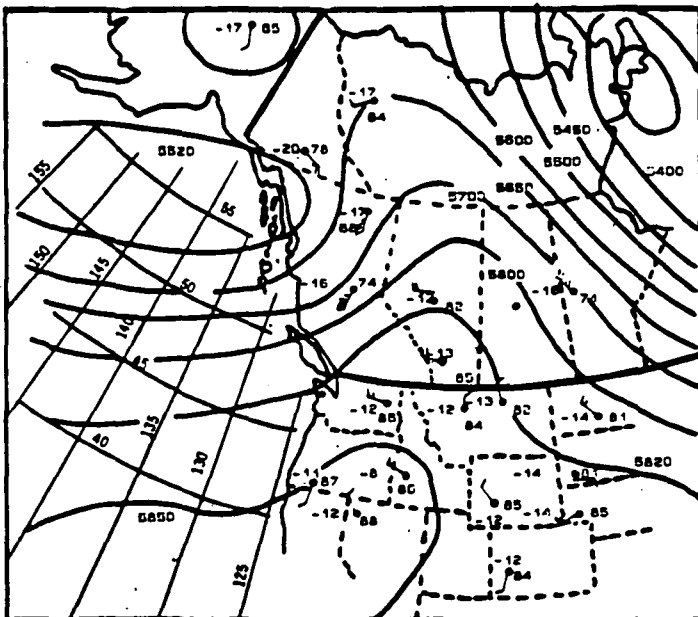
Map # 118 - 500 mb chart -
June 28, 1968 - 5:00 a.m.



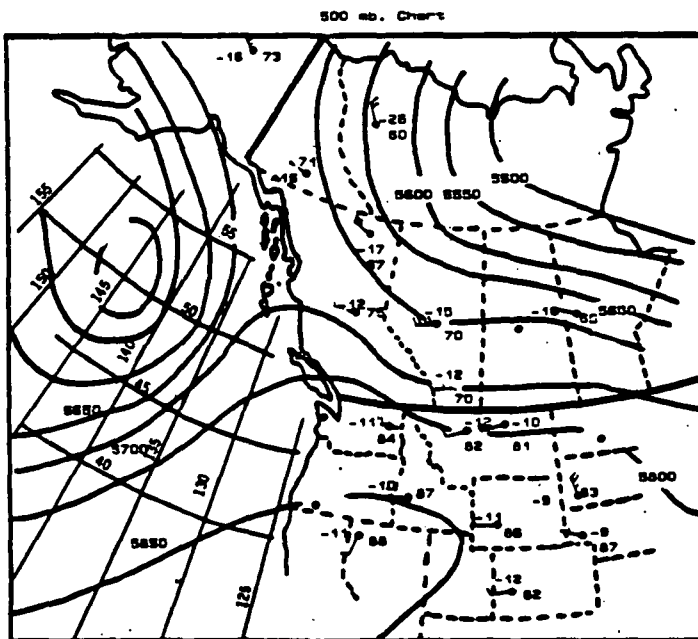
Map # 119 - 500 mb chart -
July 1, 1968 - 5:00 a.m.



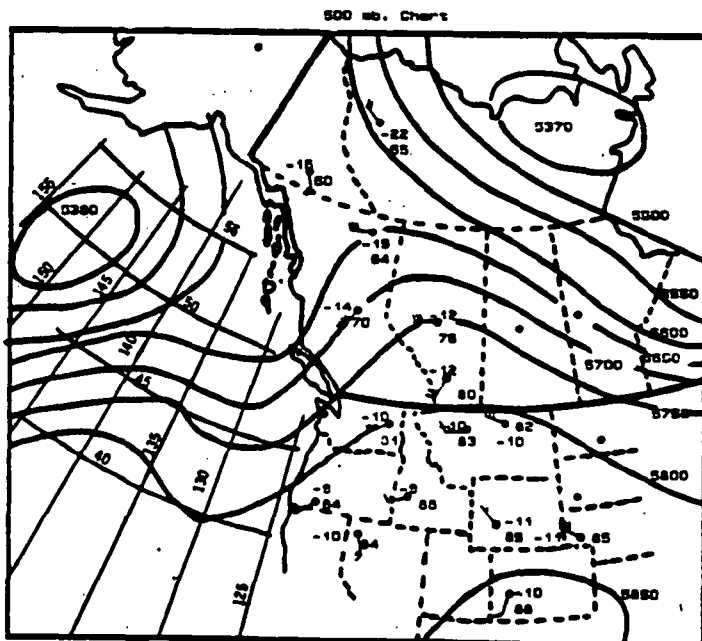
Map # 120 -
July 3, 1968 - 5:00 a.m.



Map # 121 -
July 5, 1968 - 5:00 a.m.

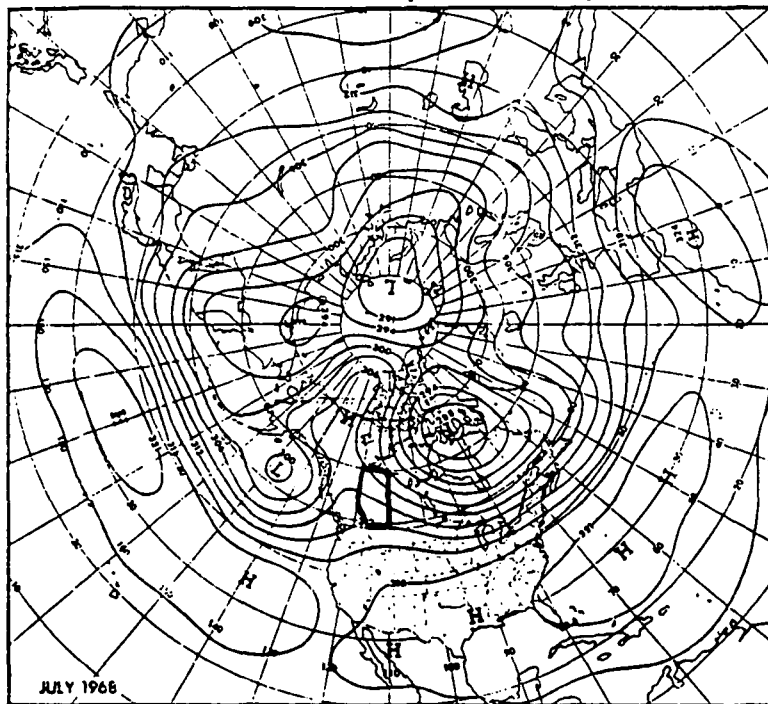


Map # 122 -
July 7, 1968 - 5:00 a.m.

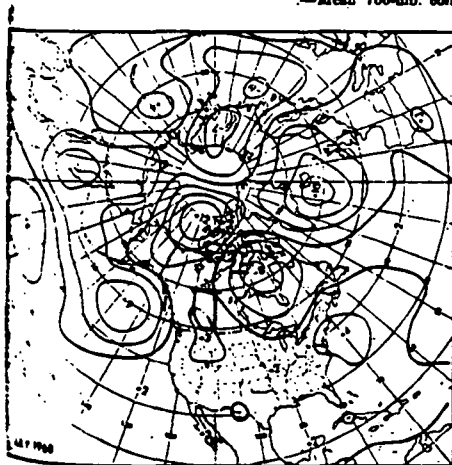


Map # 123 -
July 9, 1968 - 5:00 a.m.

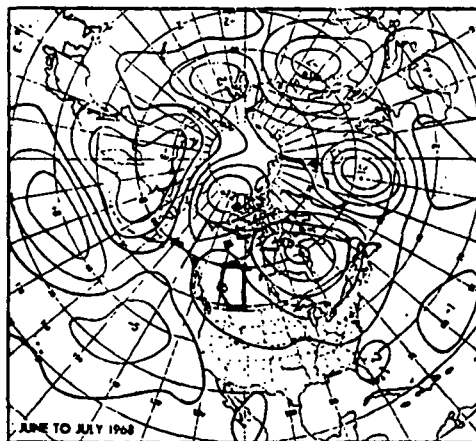
Map #124-700 mb chart - N-Hemisphere July, 1968



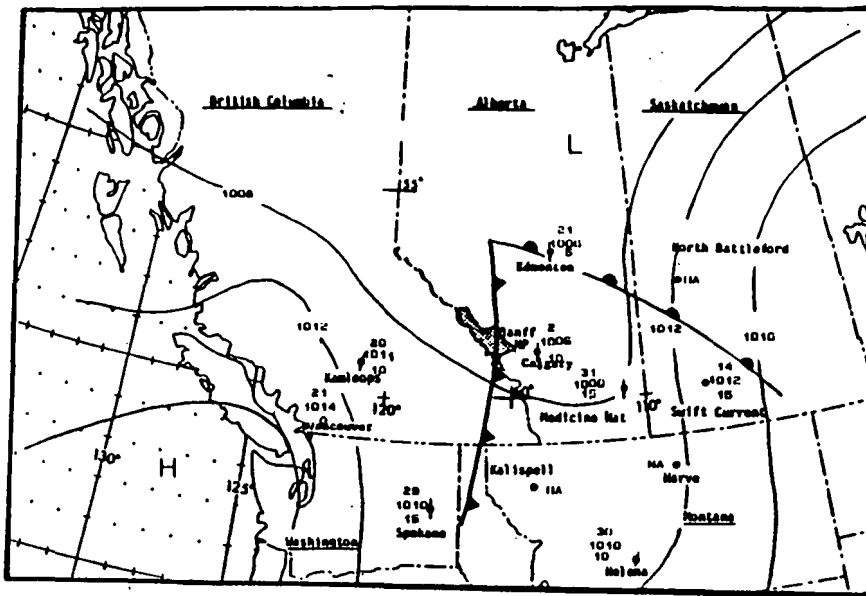
— Mean 700-mb. contours (decameters) for July 1968.



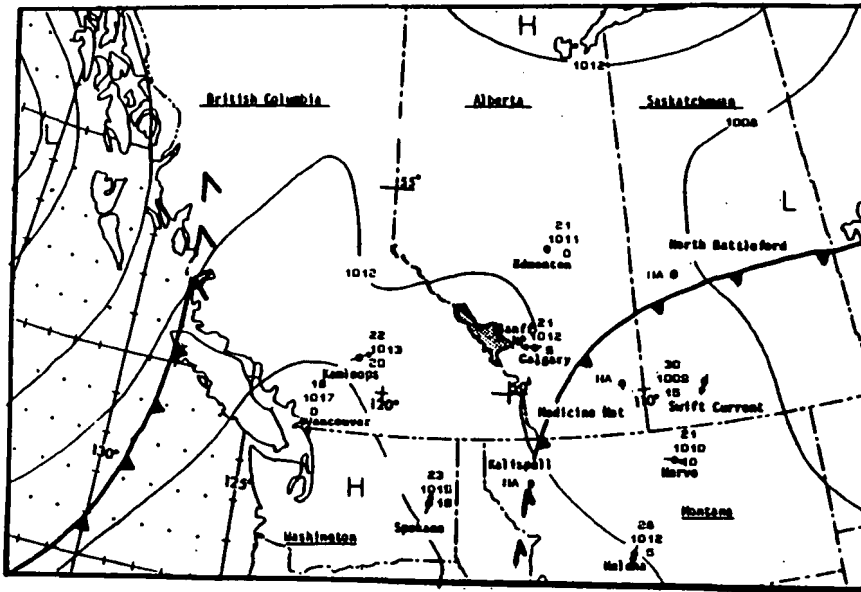
Map#125--Departure from normal of mean 700-mb. height (decameters) for July 1968.



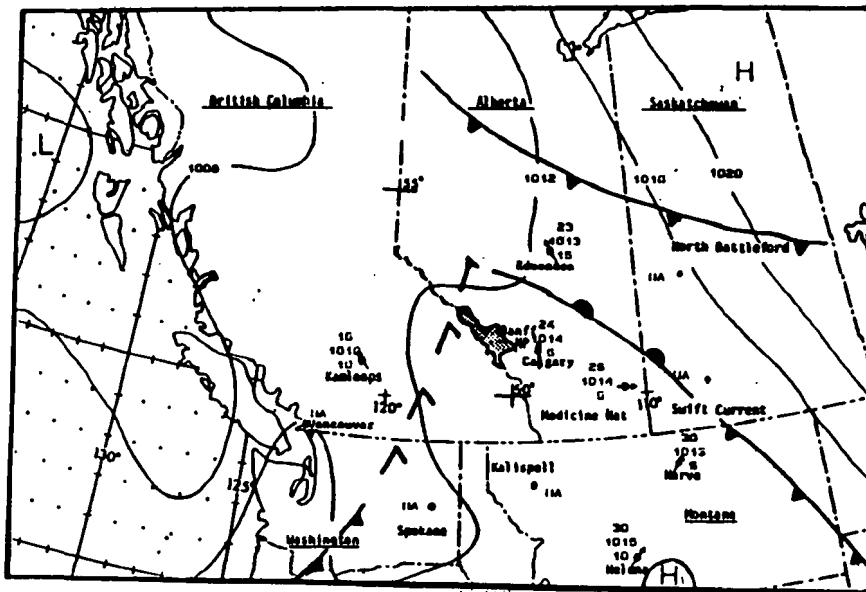
Map#126--Mean 700-mb. height anomaly change (decameters) from June to July 1968.



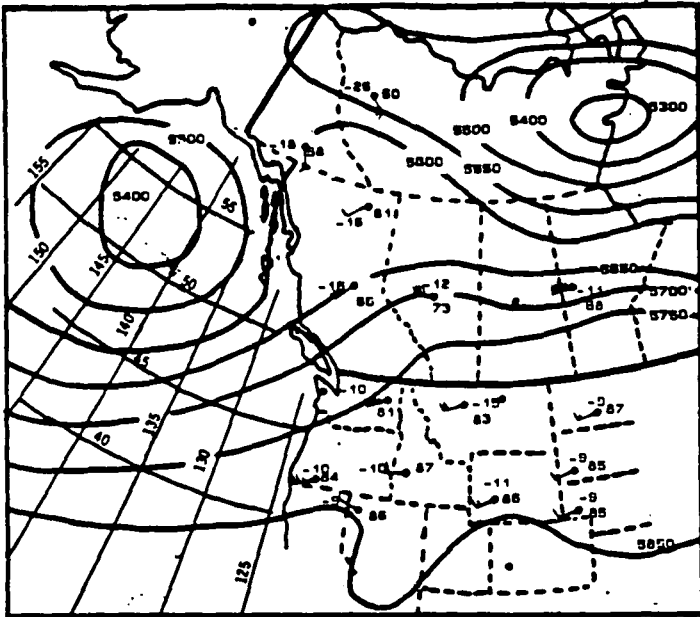
Map # 127 - Surface Map:
July 9, 1968 - 11:00 a.m.



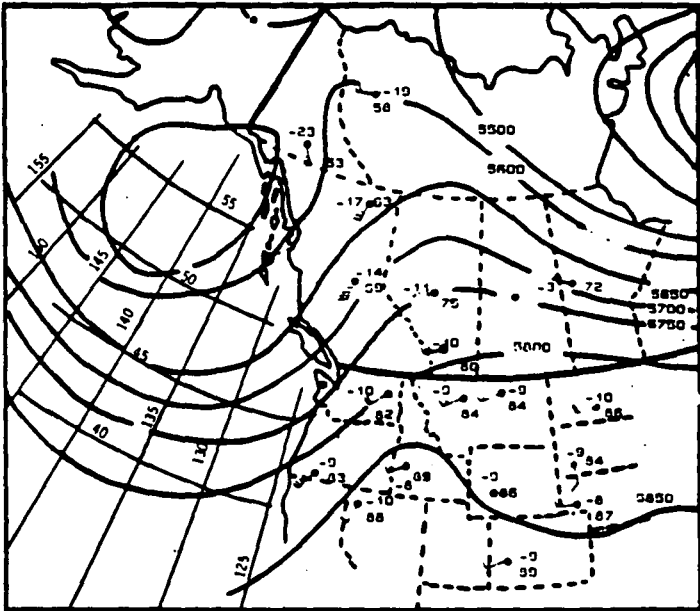
Map # 128 - Surface Map:
July 10, 1968 - 11:00 a.m.



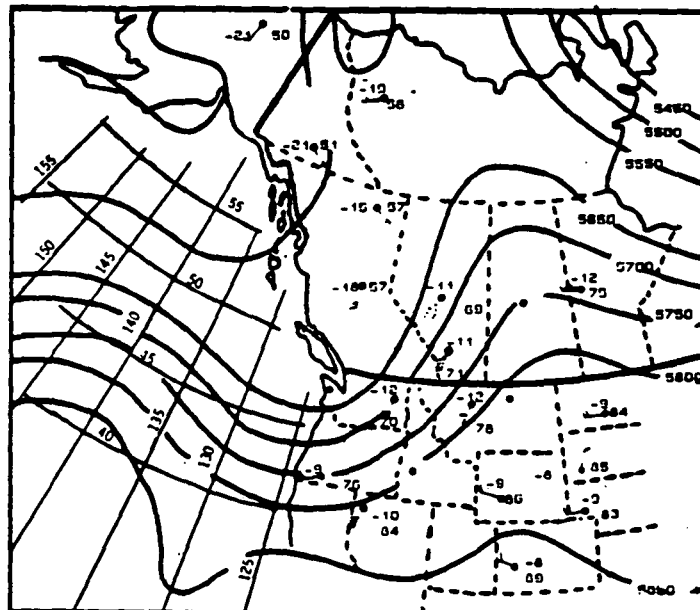
Map # 129 - Surface Map:
July 11, 1968 - 11:00 a.m.



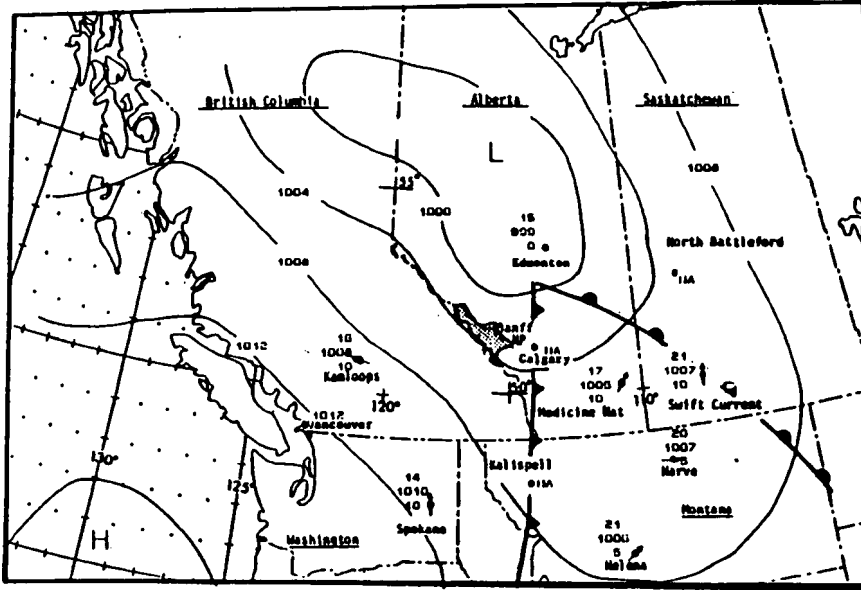
Map # 130 - 500 mb Chart-
July 10, 1968 - 5:00 a.m.



Map # 131 - 500 mb Chart-
July 11, 1968 - 5:00 a.m.



Map # 132 - 500 mb Chart-
July 12, 1968 - 5:00 a.m.



Map # 133 - Surface Map:
July 12, 1968 - 5:00 a.m.

positive height anomaly over Canada (Figure 1). This resulted in the principle cyclone track in the Pacific being well south of its normal position (Andrews 1969). As a result, record snowfall occurred in Arizona and California. Banff, being north of the track, received 55.6% of its normal December, January, February precipitation. The effects of this precipitation deficit persisted throughout the spring and into the summer, and was a major contributing factor to the magnitude of the Vermilion burn.

Map # 115 from Weatherwise 1969 depicts the circulation patterns which dominated throughout March, April and May. The positive height anomaly was not nearly as pronounced over Canada as it had been in the winter. This allowed the 700 mb westerlies for the spring to be close to their normal (Andrews 1969). With the reduced blocking and deep trough in the Pacific, as indicated by strong negative height anomaly, precipitation trends were near normal over much of western Canada. Excessive precipitation in Banff during March was probably the result of 700 mb westerlies, which had previously been much further south, making rapid movements north of their normal location. As the now warm moist westerlies trended northward, cooling resulted in high precipitation. Once resuming their normal latitudinal position, the westerlies brought 92% of the average precipitation and slightly below average temperatures throughout April and May. Under these conditions, drought-codes moderated slightly but a moisture deficit persisted in deep duff layers.

Throughout the first week of June a deep trough extended over the western coast and brought cool temperatures to Banff. This trough, as shown on Map # 116, also minimized precipitation in Banff, as most cyclonic systems were directed south due to the depth of the trough. Banff received 8.4 mm of rain on the 2nd and another 10 mm on the 6th, 7th and 8th. Castle Junction received 27 mm of rain on June 7th, 8th, 9th and 10th. This precipitation temporarily moderated the drought-code but little rain fell at Castle Junction throughout the remainder of the month, so drought-codes continued to increase.

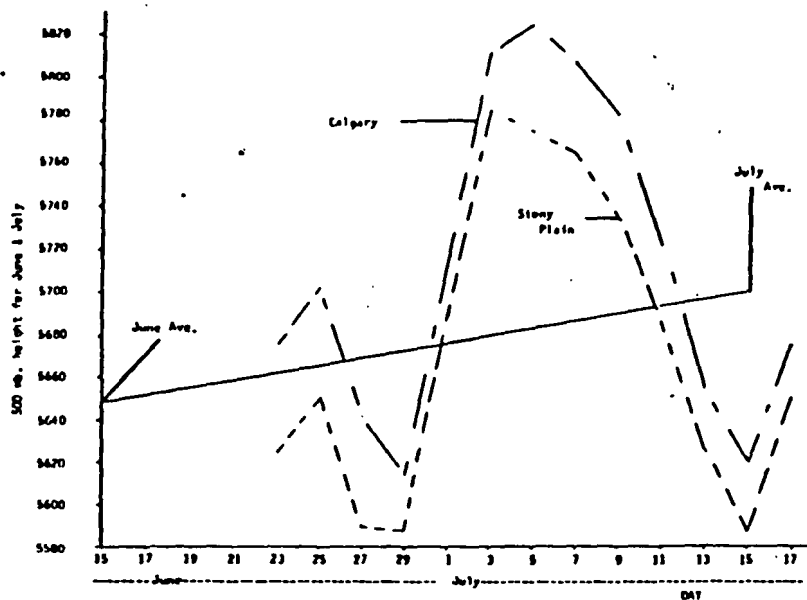
Weather remained cool for most of June, as a result of the negative 700 mb height anomaly shown in Map 117. A positive 600 mb height anomaly over the central midwestern States raised temperatures somewhat throughout the third week

of June, but no significant deviations from the normal was recorded. During the final week of June, 700 mb heights were again lower than normal, and temperatures were cool with short lived disturbances bringing some precipitation. These disturbances, although resulting in precipitation in Banff, brought little rain to Castle Junction. As the month of June came to a close, temperatures in Banff were 6^o and 7^oC on the 29th and 30th, with 9 mm of precipitation being recorded. Temperatures at Castle Junction were in the low 20's and no precipitation was recorded, even though further up the valley at Lake Louise, temperatures were 6^o-7^oC with rainfall.

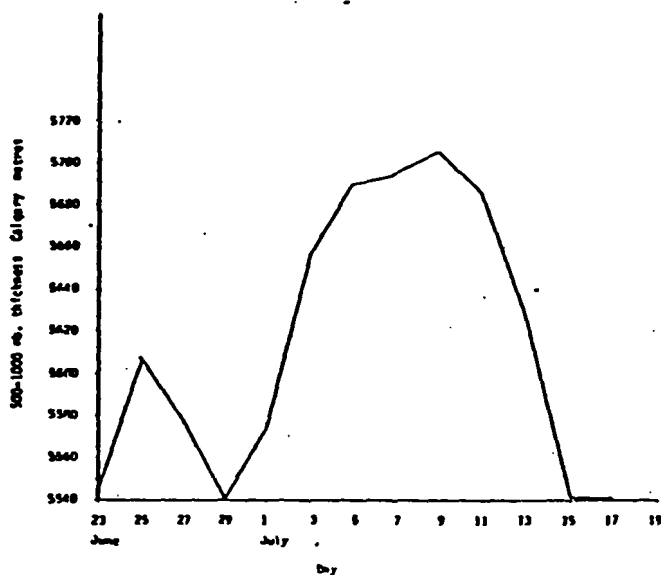
Upon examining fire weather index variables for the 30th of June, no one could have imagined that in nine days a fire would begin and behave as the Vermilion Fire did. As seen in Tables 10 and 11, fire weather index variables, with the exception of the drought-code, were all at a low danger rating with FWI being virtually zero. The drought-code, at a value of 343.8, 98 points above average, was the only indicator that any fire danger existed.

Synoptic Situation Immediate Preceding the Vermilion Pass Fire

During the first nine days of July no rain was recorded in Banff, Castle Junction or Lake Louise, and relative humidities (1200 hr) in Banff remained below 35%. This, in conjunction with daily high temperatures at Castle Junction ranging from 24^o-31^oC, and predominantly south winds, resulted in extreme rapid drying of fuels. Table 21 illustrates the severity of drying and drastic increase in fire danger.



Graph 9: 5 day average. 500 mb heights for Calgary and Edmonton June and July 1968



Graph 10: 5 day average. Thickness for 500 - 1000 mb layer June and July 1968

Table 21. Canadian Fire Weather Index Value for Banff June 21 - July 21, 1968

STATION: Banff YEAR: 1968

DATE	TEMP	RH	WS	RAIN	WD	FFFC	DMC	DC	ISI	BUI	FWI	DSR
M D	C	%	KM/H	MM								
6 21	16.1	23	16.0	0.0	S	89.7	31.7	321.1	9.0	50.8	20.5	5.68
6 22	15.6	31	0.0	0.3		90.0	34.7	327.3	4.2	54.9	12.0	2.21
6 23	8.0	37	0.0	0.3		30.6	21.3	316.8	0.1	36.5	0.2	0.00
6 24	17.2	28	0.0	0.0		72.1	24.3	323.3	0.7	41.6	1.3	0.04
6 25	21.1	29	13.0	0.0	S	87.0	28.9	330.5	5.5	47.5	13.6	2.75
6 26	20.6	33	12.0	2.5		80.6	27.9	337.6	3.4	46.2	9.1	1.35
6 27	15.6	33	13.0	0.3		84.9	30.8	343.8	4.1	50.3	11.3	1.98
6 28	11.1	27	12.0	0.0		73.6	33.1	349.2	9.0	53.6	21.0	5.97
6 29	5.7	31	13.0	6.1		45.3	19.8	336.4	0.3	34.5	0.4	0.00
6 30	7.2	28	8.0	3.0	S	35.1	15.3	335.5	0.1	27.4	0.1	0.00
7 1	19.3	25	5.0	0.0		73.5	18.7	342.5	0.9	32.9	1.4	0.05
7 2	22.2	24	16.0	0.0	S	89.7	23.0	350.2	0.0	39.5	18.0	4.53
7 3	25.6	20	9.0	0.0	S	93.6	28.0	358.5	10.2	46.9	21.4	6.18

STATION: Banff YEAR: 1968

DATE	TEMP	RH	WS	RAIN	WD	FFFC	DMC	DC	ISI	BUI	FWI	DSR
M D	C	%	KM/H	MM								
7 4	26.1	18	5.0	0.0		94.8	33.2	366.9	10.4	54.2	23.3	7.16
7 5	26.7	22	5.0	0.0	S	94.8	38.3	375.4	10.4	61.1	24.7	7.96
7 6	26.7	20	0.0	0.0		94.5	43.0	384.0	7.7	67.2	21.1	6.03
7 7	21.7	35	0.0	0.0		93.3	46.5	391.6	9.8	71.7	25.9	8.62
7 8	24.4	35	19.0	0.0	S	92.9	50.4	399.7	16.3	76.6	37.4	16.57
7 9	27.2	32	23.0	0.0	S	94.1	55.5	408.3	23.6	82.9	49.1	26.78
7 10	24.4	27	23.0	0.0	S	94.1	59.9	416.4	31.9	88.1	60.8	39.06
7 11	24.4	23	23.0	0.0	S	94.1	64.2	424.5	23.3	93.2	51.7	29.03
7 12	11.4	33	11.0	0.0	S	55.2	47.6	420.6	0.4	74.3	1.0	0.03
7 13	15.6	30	29.0	0.0	S	70.0	50.0	427.1	5.2	77.4	17.2	4.19
7 14	10.0	28	23.0	0.0	S	49.7	33.7	432.6	0.6	43.0	1.0	0.03
7 15	12.3	30	13.0	1.5	S	63.4	29.5	403.5	0.7	50.0	1.8	0.08
7 16	14.4	42	23.0	0.0	S	70.2	25.1	403.2	1.7	43.5	4.7	0.43
7 17	17.2	37	10.0	0.0		83.2	27.9	415.2	3.0	47.7	8.3	1.15
7 18	14.4	50	3.0	1.0		78.0	29.4	421.5	1.2	50.0	3.4	0.24
7 19	17.2	49	3.0	6.1	N	59.4	19.5	407.4	0.4	34.8	0.5	0.01
7 20	12.2	65	16.0	6.6	S	54.0	12.1	391.0	0.5	22.4	0.5	0.01
7 21	15.0	50	19.0	3.3		65.6	10.2	389.8	1.1	19.1	1.0	0.03

BANFF NATIONAL PARK — WARDEN SERVICE

The occurrence of an upper ridge, also known as an Omega Blocking Ridge, was responsible for the nine extremely hot, dry days prior to the Vermilion burn. Maps 114 through 119 illustrates the development of this upper ridge. In Map # 114, June 28th, the ridge was weak but evident off the coast. The trough over Alberta brought cool wet weather to Banff. By July 1st (Map #115) the ridge was building on the coast and the 500 mb height in Calgary was 5740 m. By the 3rd the ridge extended deep into the Yukon and, on the 5th, the 500 mb height over Calgary was 5850 m. By the 9th, it had dropped to 5800 m. Surface weather, while this type of ridge occurs, is almost always hot with low relative humidities and southerly winds.

The extent of the drying is dependent on initial moisture content of fuels and the amplitude and duration of ridge persistence.

In order to better visualize the occurrence, magnitude and duration of upper ridges, two graphs were prepared. Graph # 9 illustrates five-day average 500 mb heights for Calgary and Stony Plain, and amplifies deviations from the norm. When upper ridges occur, the height of the 500 mb level increases; conversely, upper troughs are recognized by a decrease in the 500 mb height. In the winter, the 500 mb height is on the average much lower than in the summer. Given this information it is a relatively simple deduction to see the June 30-July 10 formation of the ridge. This formation period is the time when severe drying of fuels occurs. During the 1961-1970 period, when the Stony Plain averages were calculated, the maximum July 500 mb height recorded was 5889 meters and the minimum July 500 mb height recorded was 5524. Comparing these maxima and minima values to the maxima and minima height for the July ridge gives a good indication of the intensity the ridge reached, and its subsequent collapse. On July 5, 1968 the ridge had a 500 mb height over Stony Plain of 5820 metres or 69 meters below the maximum. On July 14, 1968, the ridge had totally collapsed and the 500 mb height over Stony Plain was 26 metres higher than the minima record of 5524 m. When these upper ridges build and collapse rapidly fire weather is most severe.

Graph # 10 is also an aid in revealing the upper ridge intensity and duration, and is also applicable to understanding the behavior of the Vermilion fire. Graph # 10 represents the 5 day average thickness trends of the 1000-500 mb layer of the atmosphere. Within this layer most of our weather is generated and where most systems affecting surface weather originates. This layer increases in thickness when upper ridges prevail and decreases when troughs dominate weather patterns. With increased thickness comes classic hot dry upper ridge type weather and as seen in this graph, increasing thickness occurred from June 29th, 1968 to July 10, 1968 as the ridge built and severe drying occurred. Decreasing thickness will be discussed later in this paper when fire behavior and, in particular, extreme behavior and final cessation of the Vermilion burn are discussed.

Actually, the entire month of July was characterized by an upper ridge over the west coast of North America which showed its greatest strength over the Yukon. Maps 124, 125 and 126, Monthly Weather Review (December 1968), depict this upper ridge and document its strength. As seen in Map # 121, a positive monthly anomaly occurred over Alberta and the northwestern States, and a very strong positive anomaly occurred over the Arctic Ocean. This, in conjunction with the position and deep negative anomalies in the Pacific and Hudson's Bay, helped to strengthen the monthly ridge over western North America. As Wagner states (1968), this circulation situation had pronounced effects on local climate, and above normal temperatures occurred over most of the west. At Walla Walla, Washington, six consecutive days above 38°C and eight such days for the whole month almost broke records set in 1886. Accompanying the strong ridge, subsidence and abnormally strong insolation through the unusually clear skies and long days resulted in very high temperatures over Alaska (Wagner 1968). Daily mean temperatures at Nome, Alaska ran as much as 7°C above normal. All this proves the extreme amplitude of the July ridge.

The occurrence of upper ridges and their affect on fire occurrence and behavior have been discussed by a variety of authors: McLean & Coulcher, 1968; Finklin, 1973; Nimichuk, 1983; Alexander et. al. 1983. Recently, more attention has been placed on examining the breakdown of these ridges and subsequent

effects on fire behavior. The breakdown of the 10 day ridge in 1968 appears to have definitely affected the Vermilion Pass fire behavior and will be discussed at greater length in the fire termination section.

Surface map analysis for the first week of July reveals that high pressure dominated as the upper high developed over western North America. On July 1st, a high pressure system (1028 mb) over Alberta and Montana brought warm temperatures under clear skies and winds from the south. By the 3rd, the center of the high was over the central States but high pressure prevailed over Alberta, resulting in continued high temperatures and southerly winds. A low pressure system over the Yukon began to influence Alberta's weather on the 3rd, and slowly began moving southeast. On the 3rd, an Arctic cold front was pushing into Alberta but did not persist. By the 5th the low of the 3rd was centered over north-western Alberta and its accompanying cold front was west of Banff. This cold front passed over Banff in the evening and was situated over Saskatchewan on the 6th as the low quickly tracked eastward. This cold front had little effect on the Banff area so temperatures remained high. A weak high pressure system was situated directly over Banff on the 6th and by the 7th had been replaced by a weak low. Temperatures moderated slightly on the 7th but no precipitation was recorded in Banff, Lake Louise or Eisenhower Junction. High pressure, warm temperatures and south winds prevailed over Alberta on the 8th as the low of the previous day dissipated. A well developed low pressure system in the Alaska Panhandle began influencing British Columbia weather on the 8th, and a cold front lay along the coast. The occurrence of this low pressure system and its eastwardly tracking cold front played an important role in creating the instability that would result in the dry lightning start of the Vermilion burn.

Synoptic Situation During the Vermilion Burn

Perhaps one of the most important characteristics of an upper ridge or "Omega Blocking" high is its ability to block or reduce the magnitude of low pressure systems developing over a given area. Nimchuck (1983) suggest that the breakdown of these upper ridges is strongly associated with a high incidence

of lightning ignition and severe fire behavior. Map # 121 indicates the initial breakdown of the upper ridge occurring on July 5th and continuing slowly until the 12th when a major collapse occurred. This slow breakdown is usually associated with the passage of a short wave trough. This typical situation occurred on July 9th, as shown in Map # 123.

The low pressure system in the panhandle, which had been blocked from entering Alberta, began to do so as the ridge broke down. As this occurred, a wave pushed in through British Columbia during the day and, by 18:00 Z (1 pm Banff time), Banff was in the warm region of the wave with the cold front to the west. As a result of the extensive surface heating and convective activity, approach and passage of the cold front resulted in extreme instability. This instability brought lightning which was not accompanied by rain due to the still influential upper ridge. As a result of the high temperatures and extreme drying of the past week, ignition and spread occurred rapidly. Smoke was first observed at 4:40 p.m., 10 minutes after the strike, and by the time initial attack occurred, the fire was beyond a manageable size. By 6:00 p.m., under hot dry conditions compounded with winds from the southwest, the fire was rapidly moving northeast as a running crown fire.

The upper ridge (Map # 130) continued to break down on the 10th and the low pressure system of the previous day tracked eastward over Saskatchewan. The cold front lay over southern Alberta (Map # 128). Barometric pressure was rising as a high pressure system off the U.S. west coast moved inland. Fire intensity grew throughout the morning of the 10th and, as temperatures increased, so did all FWI variables. At 13:30, under the influence of a geostrophic west winds, the fire blew-up and began moving eastward as a running crown fire. Winds were reported as variable but predominantly from the south in Banff. The 1000-500 mb thickness now began to show signs of decreasing, as shown by Graph # 10, and the 500 mb height over Calgary continued to fall but remained above average. The low pressure cell in the panhandle reorganized on the 10th and another cold front appeared along the coast, west of the high pressure system (see Map # 128). Full scale suppression efforts showed no results throughout the day.

As shown in Map # 131, the upper ridge appears to have been tracking east and weakening, and a trough off the British Columbia coast was deepening on the 11th. As this occurred, the wave shown on the July 11th surface map moved inland over British Columbia and Alberta. The 5 day average mb height, Graph # 10, indicates that the 500 mb level was almost normal and the 1000-500 mb thickness was showing signs of decreasing. Banff lay in the warm sector of the surface wave, with temperatures dropping slightly and winds being from the south due to gradient flow.

The fire was still burning out of control and at noon blew-up again. This behavior was most likely a result of instability caused by the advancing cold front which was just west or above the fire. Fire control efforts were futile and were diverted to save the Storm Mountain Lodge. As the day progressed and the cold front tracked east, the first signs of the fire slowing occurred. Winds shifted to the northeast in the evening and temperatures dropped but no rain fell. An Arctic high pressure system appeared over Saskatchewan and the North West Territories which seemed to impede the eastward progress of the coastal low pressure system and its accompanying frontal wave.

Synoptic Situation at the end of the Vermilion Fire

Throughout the evening of the 11th and following day, it became evident that a major synoptic change was occurring. The July 12th 500 mb chart, Map # 132, reveals that the upper ridge had tracked eastward and was centered over Saskatchewan. A deep upper trough was now moving into British Columbia, and the previous day's low had moved into Alberta and deepened. Map # 133, July 12, illustrates this trend and also reveals the continued frontal development. The well defined cold front was east of Calgary and temperatures in Banff fell to 11.7°C along with 3.6 mm of rain. The 500 mb height over Stony Plain and 1000-500 mb thickness over Calgary continued to decrease as the upper trough began to dominate Alberta's weather. From this point on, the Vermilion Fire made no appreciable advances.

The weather of July 13th was similar to the previous day, except that temperatures climbed slightly and less rain fell in Banff. The 500 mb height at Stony Plain dropped 140 m to 5500 m during the 13th, as the upper trough dominated the weather. Continued cooling occurred and, on the 14th, 8.1 mm of rain fell in Banff. Rain fell over much of the Rockies as the upper trough dominated weather patterns for the next week. The 500 mb height at Stony Plain remained low and the 1000-500 mb thickness reached its minimum value of 5500 m on the 14th. It did not significantly increase for several days. Associated with decreased thickness of this layer are cooler air masses and greater instability. Upon examining weather trends throughout the 2nd-3rd week of July, this pattern of cooling with intermittent precipitation prevailed.

DISCUSSION

Seven seasons and ten separate fires were scrutinized in this synoptic analysis. No two fire seasons or fires are or will ever be the same - but similarities do exist. It is through understanding these similarities that park staff hope to make better fire management decisions.

Synoptic Summary Table

In order to identify trends in weather variables during the seven seasons analysed, a synoptic summary table was prepared. Table 22 lists 22 weather variables that influence the occurrence, behavior, and cessation of wild fires in Banff National Park. These variables and their importance in fire danger determination are dynamic in their nature. That is, any specific variables influence on the fire danger may fluctuate in response to the other variables and that time of year. For example, significantly deficient over-winter precipitation may have a dramatic effect on spring fire danger. However, if rainfall significantly in excess of monthly norms occurs in late spring, fire danger throughout the summer may be greatly reduced. These variables and their effects are as follows:

1. Percent of normal winter precipitation

The percentage of total normal (1951-1980 mean) precipitation for December, January and February is particularly important to early season fire danger in the montane ecoregion. Less than 60% can result in extreme fire behavior.

2. Percent of normal spring precipitation

The percentage of total normal (1951-1980 mean) precipitation for March, April and May is important to spring and early summer fire danger. Less than 60% can result in extreme behavior.

Table 22: Weather Variables influencing fire occurrence and behavior in Banff National Park

FIRE NAME AND DATE OF OCCURRENCE	MORaine LAKE FIRE JULY 24-31, 1904	LAKE LOUISE FIRE AUGUST 5-X, 1904	CASTLE JUNCTION FIRE JULY 4-13, 1906	ANTHRACITE FIRE AUGUST 4-15, 1906	CASTLE JUNCTION FIRE AUGUST 8-11, 1908	CUTHEAD CREEK FIRE AUGUST 12-14, 1924	SILVERHORN FIRE JUNE 23-28, 1936	FUNTS PARK FIRE AUGUST 6-11, 1936	SABK CROSSINGS FIRE JULY 2-7, 1940	VERMILION PASS FIRE JULY 4-15, 1968	
	1404	1904	1406	1406	1408	1424	1436	1436	1440	1468	
% OF NORMAL WINTER PRECIP. DEC. JAN. FEB	40.0	40.0	36.4	36.9	100.8	57.4	63.2	63.2	65.4	81.8	
% OF NORMAL SPRING PRECIP MAR. APR. MAY	92.1	42.1	87.8	87.8	138.8	101.0	68.1	68.1	56.3	87.0	
% OF NORMAL SUMMER PRECIP JUNE JULY AUGUST	79.8	74.8	70.4	70.4	80.3	51.5	60.3	60.3	64.13	40.8	
DEVIATION OF START UP DROUGHT CODE FROM NORMAL (55.3)	* 11.5	* 11.5	* 202.4	* 202.4	* 15.5	177.1	348.7	348.7	18.1	174.6	
% OF PRECIP PRIOR TO FIRE (MONTHS)	3	81.0	81.2	83.8	110.0	89.4	95.3	51.2	72.8	42.4	87.4
	2	110.0	52.4	146.1	74.1	63.4	33.5	53.7	62.4	40.5	77.5
	1	52.1	77.3	79.1	53.3	40.4	42.5	75	33.7	94.1	102.0
DAYS PRIOR TO FIRE WITHOUT RAIN IN EXCESS OF X MM.	1	11	5	7	9	7	3	9	25	8	0
	2	12	5	7	9	11	3	9	26	31	9
	20	35	46	12	38	43	69	20	65	31	40
TEMP. ON IGNITION DAY °C	16.4	24.2	29.8	22.0	24.2	23.7	24.2	26.4	23.7	27.0	
D.C. ON IGNITION DAY	434	445.2	382.7	559.4	376.6	544.7	500	622.4	375.4	399.4	
# POINTS D.C. ABOVE NORMAL	64	90	120	160	34	132.7	260	264.4	106.4	108.4	
PRESENCE OF H. PRESSURE ON IGNITION DAY	D.A. - TO W.	D.A.	S. SASK BC. WEST	S. SASK	S. SASK BC. WEST	D.A.	---	---	MONTANA	SASK.	
PRESENCE OF L. PRESSURE ON IGNITION DAY	S. ALTA	S. B.C.	N. ALTA	N. ALTA	TROUGH IN EVENING	SW OF YBA	P.A.	D.A.	DA - NE	D.A.	
BAROMETRIC PRESSURE - TENDENCIES ON IGNITION DAY	1013 ↑	1021 ↓	1019 ↑	1020 ↓	1014 ↓	1016 ↓	1012 ↓	1005 ↑	1012 ↑	1006 ↑	
WIND SPEED + DIRECTION ON IGNITION DAY	W / 38	SE / 10	SE / 25	SE / 10	SE / 10	C.	NE / 19	S / 15	S / 5	S / 22	
PRIMARY WIND SPEED + DIRECTION FIRST FEW DAYS - KM/HR.	VARIABLE W /	VARIABLE	VARIABLE S-SE / 10	E-SE / 10	VARIABLE SE-SW	SE / 10	VARIABLE	S-SE	S / 5	S / 29	
BURN DIRECTION	E	UNDEFINED	UNDEFINED	NE	NE	SE	SE	NE	NE	NE	
OCCURRENCE OF UPPER RIDGE AFFECTING FIRE	---	---	---	YES	---	YES	YES	YES	YES	YES	
FRONTAL PASSAGE ON IGNITION DAY	NO	NO	POSSIBLE	NO	NO	NO	POSSIBLE	YES	CF PA	WAVE ↑	
FRONTAL PASSAGE ON INCREASED FIRE ACTIVITY DAY OR MAJOR RUN	NO	NO	POSSIBLE	YES ON 7TH	YES 9TH AM	YES ON 13TH	YES ON 27TH	YES ON 9TH	YES 2+3	YES 9+10	
FRONTAL PASSAGE ON FIRE CONTROL OR CESSATION DAY	YES ON 27-29	NO	NO	YES ON 12TH	NO	YES ON 18-19	YES	YES ON 13-14	S OF YBA	WAVE + CF	
PRESENCE OF L PRESSURE ON FIRE CONTROL OR CESSATION DAY.	YES ALTA SASK BC	YES DA - TO W	SASK	D.A.	MONTANA + SASK.	D.A. + N.E	E OF YBA	D.A. ON 13TH + E. ON 14TH	MONTANA + B.C.	D.A.	
WIND SPEED AND DIRECTION ON CONTROL OR CESSATION DAY.	NW / 14 ON 17TH	W / 14 ON 7TH	NE / 10	NE / 26	N / 13	NE / 10	N / 10	NE / 15	NE / 3	N / 13	
PRECIP ON CONTROL OR CESSATION DAY - MM.	10.4 ON 27-29	4.7 ON 7TH	8.6 ON 13TH	10.6 ON 12-13-15	9.1 ON 11TH	7.4 ON 14TH	1.5 ON 27TH	4.7 ON 14TH	16.0 ON 2+3 +5-6	12.6 ON 14-15-16	

3. Percent of normal summer precipitation

The percentage of total normal (1951-1980 mean) precipitation for June, July and August is important to summer and fall fire behavior. Less than 70% can result in extreme fire behavior.

4. Deviation of start-up Drought-code from normal

This is a good indication of actual spring fire danger and possible fire danger throughout the summer. Positive deviations from the average start-up code (approximately 70, see Graph 1) in excess of 100 points indicate high fire danger in the montane ecoregion. Positive deviations in excess of 200 points indicate serious moisture deficits in the deep duff throughout the Park, and may result in extreme fire behavior in the subalpine ecoregion. From 1890 to 1980, 12 years had start-up drought-codes in excess of 200. Of these 12 years, 9 years had major fires.

5. Percent of average precipitation in Spring/Summer months immediately prior to fire.

Two months with less than 80% average precipitation can result in high hazard. Less than 65% of average precipitation over 3 months will result in critical fire danger.

6. Days prior to fire without substantial rain.

As the number of days without substantial rain increase, the fire danger will increase exponentially. Twenty days without rain in excess of 20 mm can result in high fire danger (depending on long term drying conditions). Thirty days without rain in excess of 20 mm will result in extreme fire danger.

7. Temperature on ignition day

Temperature in excess of 20°C is of importance, particularly if days without rain is greater than 20.

8. Drought-code on ignition day

This factor is important in conjunction with temperatures greater than 20°C and more than 20 days without rainfall in excess of 20mm. Drought-codes greater than 200 in early season can indicate high fire danger, greater than 350 on any day can indicate high danger and greater than 500 on any day indicates extreme danger.

9. Number of points drought-code is above average

Drought-codes 50-100 points above the 1970-1980 mean (Graph 1) can result in moderately high fire danger with 20 preceding days without substantial rain, and temperatures in excess of 20°C. Drought-codes 100-200 points above average indicate high to extreme. Greater than 200 points above average indicate very extreme conditions. Again, the drought-codes main value is to indicate drying in the deep duff layers and drying at elevations above the Banff station.

10. Presence of high barometric pressure on ignition day

High pressure does not always prevail on ignition day, but the normally warm and dry weather associated with surface highs is of major importance to fuel dessication immediately prior to ignition day.

11. Presence of low barometric pressure on ignition day

Low pressure may be particularly important on ignition day, particularly if it follows a week or more of high pressure and hot weather. These lows may not bring rain immediately. However, instability behind the cold front may result in dry lightning and strong erratic winds.

12. Barometric Pressure trends on ignition day

The rapid dropping of barometric pressure often occurs on ignition day, indicative of increasing atmospheric instability.

13. Wind speed and direction on ignition day

Strong southerly winds (SE,S, SW) are usually present on ignition day. Surface winds are usually hot ($\geq 20^{\circ}\text{C}$), dry ($< 30\% \text{ RH}$) and erratic, posing severe problems for fire control.

14. Primary wind speed and direction during period of burning

Strong, southerly winds often occur during the major burning periods. However, variable wind directions, or a pronounced shift in direction from southerly to northerly quarters occurs when cold fronts preceding low pressure systems cross the park. Fire behavior under the influence of dry cold fronts is often severe.

15. Direction of Burn

An easterly direction of burn is the common feature of all fires. North-east burning fires also are common due to the influence of southerly winds.

16. Occurrence of upper ridge over Park area

A ridge of high pressure at the 500 mb level usually brings hot, dry weather. The persistence of a ridge can increase fire danger from low to extreme in very short periods (5 - 10 days). When the ridge breaks down, extreme atmospheric instability can occur, with strong erratic winds. The presence of an upper ridge and its subsequent break down can generate the worst fire weather occurring in Banff National Park.

17. Frontal Passage on ignition day

Passage of a cold front may result in lightning caused fires.

18. Frontal Passage on day of Major fire run

Cold fronts, particularly if they are dry, result in strong erratic winds that often cause the blow-up conditions associated with major fire runs in Banff Park.

19. Frontal Passage on Fire control or Cessation Day

Cold fronts are frequently followed by precipitation and always marked by diametric wind shifts. These factors are fundamental to stopping fire spread.

20. Presence of Low pressure on Fire control or Cessation Day

The influence of cyclonic (anti-clockwise) disturbances are key elements in controlling fire activity. Rain, falling temperatures, increasing relative humidity, and wind shifts accompanying low pressure systems resulted in the cessation of all the fires evaluated.

21. Wind spread and direction on Fire control or Cessation Day

Low pressure cyclonic winds are usually upslope and from the north. This is in direct contrast to the southerly winds that often cause initial fire spread. The switch in wind directions funnelled by the mountain ridges, can result in fire fronts being blown back into previously burned areas. Probably this interaction between atmospheric and topographic conditions is critically important in limiting fire size in Banff park. Since 1890, no fires have exceeded 8000 ha despite little demonstrable effects of man's suppression actions on large fires. (White 1982).

22. Precipitation on Fire control or Cessation Day

All the fires evaluated were ended by periods of rainfall. The heavy subalpine fuels and extreme fire behavior associated with most large fires have extreme resistance to man's control efforts. Thus, rain can be essential to control fires exceeding 40 ha in size - even with modern fire fighting equipment.

Fire Season Categories

The seven seasons scrutinized in this analysis have been classified as being in one of four fire season severity categories. These categories classifications are based on fire behavior and size, a definition of each is as follows:

Low Severity Season:

Few fires greater than 40 ha in size. Fire behavior is not extreme. These fires spread slowly in no pronounced direction and are extinguished by rain when they are still relatively small.

Moderate Severity Season:

Defined by uncontrollable fires burning in variable directions with moderate intensities. These fires reach sizable dimensions (1500 ha) and pose significant control problems until they are doused by rain.

High Severity Season:

Seasons characterized by high intensity, uncontrollable fires, experiencing some blow-up conditions.

Extreme Severity Season:

Seasons typified by large scale fires (2000 ha) often experiencing blow-up conditions on successive days. Fires falling in this category are totally unmanageable except through back burning, and are often completely beyond the realm of current fire suppression techniques. Fires of this category, if in close proximity to the Banff or Lake Louise townsites, pose severe danger to the townsite facilities.

Another fire season category could be added to this rating system, a "very low severity fire season", when no fires greater than 40 ha in size occur. This discussion will be examining synoptic conditions leading to the occurrence of each category of fire season. Table #22, Synoptic Summary, compares all fires examined in this analysis, and is very useful in evaluating fire season categories.

Low Severity Season (1904)

Appropriately, this discussion continues with an interpretation of atmospheric conditions which lead to low severity fire seasons. The 1904 season is a typical season classified in this category. Winter and spring precipitation was insignificantly below normal and it wasn't until July and August that moisture deficits prevailed and forest fuels reached flammable conditions. (Flammability increased exponentially as drought-codes rise above average drought-codes). High temperatures and low precipitation throughout the month of July were the factors which led to the minor fire hazard. This situation persisted throughout August as the monthly synopsis revealed less than 80% of the normal precipitation, with temperatures remaining warm. With fuel moisture being deficient and drought-codes being 50-100 points above normal, the wildfire stage was set.

Ignition of the 1904 fires is attributed to man's presence in the Bow Valley. Throughout the first few days of both fires, high pressure systems affected local weather, and temperatures ranged from 20°C-25°C. The location and tracking of the high pressure systems were different for both fires, and resulting winds brought about similar fire behavior but different burn directions. Winds were from the west during the Moraine Lake fire and the resultant burn direction was eastward. The Lake Louise fire was influenced by variable winds and the burn direction was therefore not consistent. Blow-up conditions did not prevail during either fire and, although the situation was uncontrollable, fires remained relatively small.

Low pressure dominated weather at the end of both fires, and the resulting instability brought rain in excess of 10 mm. These low pressure systems promoted

a north-northwesterly flow and cool temperatures. Fire spread ceased, and fire control efforts brought about the cessation of the fires. In today's fire suppression age, both fires could have been controlled and extinguished quickly by using common fire suppression tactics.

Moderate Severity Season (1906)

The second category, moderate fire severity season, is typified by the 1906 season. The beginning of 1906 was plagued by extremely low winter and early spring precipitation. January, February, March and April all recorded monthly precipitation totals that were 50% of the normal value. As a result, spring start-up drought-codes were at an extreme value, 200 points above normal. Finally, in May, 146% of the months normal precipitation was recorded and the moisture deficit was significantly reduced. Had the badly needed rain not occurred, the fire season would have undoubtedly been classified as extreme. Moisture deficits continued throughout the summer and the total summer precipitation amounted to 70% of the normal.

Ignition of both 1906 fires is again attributed to man's presence in the Bow corridor. High temperatures and low precipitation resulted in drought-codes 120 points above normal, setting the stage for a major conflagration in the Bow Valley. The weather during the first days of the Eldon fire was dominated by a surface high pressure system. As barometric pressure remained high, strong southeasterly winds, in conjunction with 29°C temperatures, brought about high fire intensities and rates of spread. The weather just prior to the Anthracite fire had been warm as high pressure prevailed. However, a trough dominated weather on the first few days and temperatures were moderate. Southwesterly winds brought about a northeasterly burn direction.

Both fires were terminated by rainfall in the order of 10 mm; however, the synoptic patterns which brought about rainfall are different for the two fires. The Eldon fire was terminated by precipitation from a moist maritime low off the British Columbia coast. As this low pumped moist air inland over

the Rockies, orographic precipitation occurred. A high pressure system which lay over central Alberta and northern Alberta promoted upslope winds, which resulted in rain in Calgary and may have helped to promote widespread precipitation in the Rockies. Unlike the synoptic situation at the end of the Eldon fire, a well developed low extending from central British Columbia through Alberta brought rain to terminate the Anthracite fire. This system dominated weather throughout the last three days of the fire with the most significant rainfall occurring on the last fire or termination day. As the low tracked east on the 12th, 13th and 14th, 2 mm of rain was recorded in Banff. On the 15th the low lay over the Saskatchewan-Alberta border, northeast, bringing upslope winds and 9.1 mm of precipitation. Both of these fires were uncontrollable in 1906. Today, control might be possible by using the most advanced suppression techniques available. The cost of terminating such conflagrations would be extremely high.

High Severity Season (1908 & 1929)

Both fire seasons, 1908 & 1929, may be classified in the 3rd fire season category, the high fire severity category. Although synoptic and climatological conditions for the two fires are different, fire size was approximately the same and both fires are therefore classified in the same category. The conditions which increased the magnitude of the Castle Junction fire occurred extremely rapidly. In contrast, the climatological scenarios which brought about the Cuthead Creek fire developed over several months.

In 1908, over winter precipitation was normal. Spring precipitation was 30% above normal and summer precipitation was 80% of the normal similar to the 1904 season. As a result, start-up drought-codes were approximately normal. A moisture deficit persisted throughout July but was not severe, with the monthly rainfall being 63% of the normal. Little rain fell during the first week of August and, by the 7th, the drought-codes were only 34 points above normal. The Castle Junction fire probably ignited on the 7th near Twin Lakes, but remained a low intensity fire throughout the 8th. Fire control efforts were quite successful and, on the morning of the 9th, the fire was under control. The synoptic situation took a turn for the worse in the afternoon and the fire blew-up. A

dry trough extended into Alberta from the Yukon during the day and developed into a well defined low. With this low came a distinct cold front. Extreme instability, caused by the rapid movement of the front, resulted in strong variable winds and the fire quickly became a running crown fire. Under primarily southwest winds, the fire burned in a northeast direction towards the Bow River. In the next 1½ hours the fire had burned 13 km across a 4 km front and consumed most of the 5000 ha total burn size. Intensity and rate of spread of this fire was extreme. Present day control efforts would be totally ineffective at diminishing spread, and back burning under such climatological conditions would only increase the final fire size and jeopardize lives.

Two factors brought about the demise of the 1908 Castle Junction fire. On the 9th, as the fire raced northeast towards the Bow River, it burned into an area which had previously been consumed by the 1906 Eldon fire. With greatly reduced fuel loadings, the fire intensity quickly died down. Also, by the 11th, a low over Montana and a high over northern British Columbia promoted a northeast flow and upslope winds. Precipitation fell in Banff and the fire at Castle Junction was extinguished.

The Cuthead Creek fire, like the Castle Junction fire, was also a major conflagration. However, intensity and rate of spread of this fire, unlike the Castle Junction fire, appears to have been not as severe but was sustained for several days. The synoptic patterns which contributed to the creation of such a large fire are also quite different from those that influenced the 1908 fire. In contrast to the 1908 season, extreme drought throughout the winter and summer had major influences on the Cuthead Creek conflagration. December, 1928, and January and February, 1929, precipitation amounted to less than 60% of the norm. Precipitation in March and April was in excess of the norm but drought still persisted and the spring start-up drought-code was 177 points above normal. May precipitation was again less than 60% of the norm but, in June, precipitation in excess of the norm by 38%, was recorded. July and August precipitation amounted to 38% of the norm and no rainstorm in excess of 10 mm was recorded.

On ignition day the drought-code was 130 points above normal and, as temperatures rose to the mid-twenties, the fire, once ignited, grew rapidly.

Recreation is attributed to the cause of ignition. A high pressure system directly above Banff brought clear skies and warm temperatures, but it dissipated throughout the day and a low replaced it. As this situation occurred, downslope winds moved the fire down the valley. On August 13th and 14th a dry trough and cold front influenced weather in the Rockies. This situation was very similar to the one that resulted in such intense fire behavior in the 1908 Castle Junction fire. The cold front appeared to be weaker than that of the 1908 system, with the most intense portions lying north of Banff. Fire intensity and rate of spread may have increased at this time but actual fire behavior is unknown. West-southwest winds prevailed and the fire continued to burn uncontrollably down the Cascade Valley. This dry trough brought little precipitation and the fire continued to spread until the 18th.

Fire control and cessation occurred as a small but well developed low passed over the Rockies on August 17th and 18th. As the low lay over Alberta on the 18th, winds came from the north and northwest, blowing the fire southward down the Cascade Valley. This low, unlike the low of the 13th, brought rain. As temperatures fell and the fire was situated under the cold portion of the low, fire intensity decreased and spreading ceased.

Attempts at fire suppression on the 1929 fire were ineffective. Even using present-day suppression techniques and tools, control would prove to be extremely difficult and expensive. Short term fire blow-ups, like in the 1908 season, are completely beyond the realm of fire control. Should such a fire occur again in the Bow Valley, Wardens will be concerned with only one course of action - evacuation. Under such intense fire behavior conditions, it is quite possible that even this course of action would not be totally successful.

Extreme Severity Season (1936, 1940, 1968)

The fourth category to be discussed encompasses fires that are the most destructive and least predictable. The 1936, 1940 and 1968 seasons fall within this category. Of the fires examined in these three seasons, climatological

factors immediately preceding, during and at the end of the fire are quite similar. Discrepancy does however exist amongst the climatological conditions which led into the occurrence of those severe seasons.

The 1936 and 1940 season both had over-winter, spring and summer precipitation that amounted to 65% of the normal precipitation. The 1968 precipitation values for this same period of time were approximately 85% of the norm. Start-up drought-codes varied amongst the seasons, with 1940 having the lowest value. Near normal precipitation in April, 1940 brought about the low value. High temperatures and low precipitation in 1968 brought about a start-up value that was 177 points above normal. The 1936 season had the highest start-up values on record, 350 points above normal. An extreme moisture deficit in April of 1936 resulted in this condition. Continued moisture deficiencies in the late spring and early summer maintained high drought-code values in the 1936 and 1940 seasons. Conditions were not as extreme in 1968 but drought-codes remained above normal.

Throughout the spring and early summers of 1936 and 1940, the occurrence of persistent upper highs brought drought to North America. These upper ridges are associated with the following climatological factors: convergence of air masses and piling-up, subsidence, adiabatic heating, low relative humidities, air mass stability, warm temperatures aloft, extreme heating at surface, increased surface albedo, discouraged cumulus growth, deviation of westerlies northward, and disruption of normal storm tracks (Namias 1980). All of these factors signal and result in the occurrence of drought. These factors brought about self perpetuation and/or building of the ridge. Destruction of the ridge by short wave troughs becomes a less probable event. The resulting fire danger, which developed at the surface under such circumstances is the most severe that occurs in western Canada and the western U.S. .

The factors which bring about these upper ridges remain mysterious to the scientific community but several theories have been presented. Perhaps the most accepted theory involves the coupling of ocean currents and air mass development (Namias 1982). When currents are particularly warm the sea surface temperature gradients to the north of the currents are enhanced. This may then

account for strong high latitude westerlies which transport air southward and result in convergence of air over the high pressure areas (Rosby 1937, Namias 1980). This occurrence has also been theorized to the Russian droughts of 1972 and 1976 (Namias 1980). Another suggestion is that high albedo in dry areas contributes a net radiative heat loss relative to its surroundings and the resultant horizontal temperature gradients induce a fractionally controlled circulation that imports heat aloft and maintains thermal equilibrium through sinking motion and adiabatic compression (Twomey & Squires 1959, Charney 1975). A third theory is based on solar-weather relationships. This theory suggests a direct correlation between the sun spot cycle and accompanying solar radiation on earth and severe drought (Mitchell et. al 1978, Willet 1965). Whatever the cause for upper high pressure systems persisting, explanation is complex, and accurate forecasting is difficult.

The upper ridge which brought about extreme fire danger in 1968 was exceptionally intense. The occurrence of this ridge over a 12 day period increased the fire weather index from 0 to 70 by the 10th day. The FFMC, DMC, ISI and BUI all attained extremely high values and fire behavior during the burn was extreme. The building and collapse of a ridge may be closely followed by observing the height of 500 mb level and the thickness of the 1000-500 mb interval at the Stoney Plain upper air station. This process is detailed in the 1968 analysis. Recently, Nimchuck (1983) suggested that extreme fire behavior in Northern Alberta is closely related to the breakdown of these upper ridges. This theory does show some validity in evaluating the 1968 burn situation.

On ignition day of the 1936, 1940 and 1968 burns, high pressure at the surface prevailed and all but the Silverhorne fire were influenced by southerly winds. The Silverhorne fire burned in a southeasterly direction under the influence of northeasterly winds but blew-up and burned in a northeasterly direction as winds veered to the southwest. All fires were influenced by frontal passages on the ignition day, with erratic and strong winds playing a key role on the first day spread and intensity. Frontal passages during all the fires also played a key role in the blow-up conditions that persisted on at least one burn-day for each fire.

Control and termination of each fire was greatly assisted by the close proximity of a cyclonic disturbance which resulted in rainfall on each conflagration. In conjunction with these low pressure systems, winds came out of the north or northwest and the fires blew back on themselves. With the exception of the Silverhorne fire, each fire had burned from 5 - 8 days and had consumed approximately 5000 ha. Fire suppression efforts only became effective at controlling spot fires and spread once rain had fallen.

Conclusion

Weather and fire are and will always be, intimate companions. This complex association is perplexed by the dynamic, unpredictable nature of weather and its equally unpredictable affect on fire behavior. The intent of this paper has been to postualte the relationships of past fire occurrence and behavior with synoptic weather patterns. This conclusion highlights the findings of the paper.

Wildfires in Banff National Park rarely occur unless the drought-code is equal to or greater than the average drought-code value for any given day. When the drought-code is 50-100 points above normal, the fire hazard will be moderate to high. Once the drought-code attains values of 100 -200 points above average, the fire hazard will be high to extreme. If the drought-code is greater than 200 points above normal, wildfires, once ignited, will be extremely difficult if not impossible to suppress. These statements are generalities and one must intently scrutinize synoptic patterns at the time of any fire to begin predicting fire behavior and danger. The Castle Junction fire of 1908 is an excellent example of a fire which ignited under low fire danger conditions but displayed extreme behavior with the passage of a dry cold front.

The occurrence of moisture deficits in the winter, spring or summer are greatly responsible for above normal drought-codes. Winter and early spring precipitation, consistently and significantly below normal, will result in high spring start-up drought-codes and early season moisture deficits. When spring start-up drought-codes are 100-200 points above normal, early season severe fire danger is probable in montane areas. If moisture deficits persist throughout late spring and summer, the likelihood of a high to extreme fire season is great. However, if significantly above normal monthly precipitation occurs in late spring and summer, drought-codes will be moderate. If spring start-up drought-codes are greater than the norm by 200 points, drought will most likely persist throughout the summer in all regions of the park, and a high if not extreme season will unfold.

During the summer in Banff, the probability of winds coming out of the south is approximately 50% (AES data). This factor, in conjunction with the southeast-northwest orientation of valleys, results in most fires burning in a northerly direction. Often, wildfires in the park, burn under the influences of surface high pressure systems which promote high temperatures ($>20^{\circ}\text{C}$), south winds, clear skies, and low humidities. Under these conditions, fire spread and intensity is often high to extreme. Fire control under such situations is extremely difficult and dangerous. The passage of dry troughs extending southward from Alaska and the Yukon often bring extreme fire behavior and blow-up conditions. Cold fronts associated with these lows bring extreme instability, high winds and little if any rain. The result is extreme fire behavior over short periods of time (3 - 4 hours). These lows move quickly and will usually pass by the following morning. If the lows influence continues to diminish, fire spread and intensity is greatly reduced. The passage of such lows often result in dramatic wind shifts and decreased temperatures.

The occurrence of intense upper ridges often result in extremely rapid drying of forest fuels. These ridges may persist for a week but may also persist for several weeks or months. Under such conditions, widespread drought prevails and a high or extreme fire season is probable. It appears that extreme fire behavior is associated with the breakdown of these upper ridges. Breakdown of upper ridges is often manifested by the passage of short wave troughs. These troughs frequently bring dry cold fronts which promote extreme instability and subsequent dramatic fire behavior. The building and demise of upper ridges may be measured by observing 500 mb heights and 1000-500mb thicknesses. The intensity of short wave troughs may be analyzed by reviewing surface pressure changes, temperature gradients across the front, and deviation of the dewpoint-temperature spread. The occurrence and demise of upper ridges bring the most severe fire danger situation occurring in Banff National Park.

Wildfires in Banff National Park are usually brought under control by the passage of cyclonic disturbances which promote north-northeast winds, cool temperatures and rainfall. These low pressure systems are situated directly above or immediately to the east of Banff, or over northern Montana when fire control occurs. Often, upslope winds in the foothills are associated with such systems and bring orographic precipitation which assists in the demise of wild-

fires. Under such synoptic patterns, fire control is attained and fire suppression tactics become effective at controlling and terminating the fire.

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