PACIFIC REGION TECHNICAL NOTES

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Heavy Rainfall on Thanksgiving Weekend 1984

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INTRODUCTION

During the period from October 7th to the morning of October 9th, 1984, a fairly broad frontal system moved onto the B.C. Coast while the associated low pressure centre moved northwards to the south coast of Alaska and filled. The frontal system stalled over the south coast of B.C. giving measured rainfall amounts of from 50 to 200 mm during the two-day period ending the evening of October 8, 1984. Severe flooding resulted in the Lillooet River valley near Pemberton and along the upper Squamish River. A further 25 to 50 mm of rain on October 9 compounded flooding problems.

SYNOPTIC SITUATION

On the evening of October 6th (Oct. 7 GMT) there was a large low pressure system off the coast with a frontal system moving on shore (Fig. 1). By 12Z on the 7th the system (Fig. 2) was marked by an upper trough along 145 W from 35N to 45N. The frontal orientation was NE-SW over the south coast and rain was being reported. Areas of cold cloud tops along the front indicated some heavy embedded convective clouds.

At this time a "heavy rain warning" was issued for the Howe-Sound Whistler area.

Twelve hours later (00Z Oct. 8) the frontal system was still across the south coast (Fig. 3) but was oriented more N-S having moved eastwards along 40N. This was due to the fact that an upper low had remained nearly stationary in the Gulf of Alaska and only the very southern end of the upper trough had moved eastwards. The frontal zone was just as active with extensive embedded convective clouds. The satellite image (Fig. 3) shows a series of very flat waves moving northeastwards along the front.

At 12Z October 8th, the frontal position over the south coast was virtually unchanged (Fig. 4) with the front now lying due north-south. Flat waves continued to move along the front with areas of heavy convection associated with each. The system was beginning to edge eastwards with the upper trough being forced east as a ridge was building along 160W ahead of the next strong frontal development.

The system moved very slowly with rain, occasionally moderate, continuing until after 00Z October 9th. The frontal system moved eastwards as the next system approached but maintained its N-S orientation.

FORECAST

Rain for this period (Saturday and Sunday) was first mentioned in the afternoon forecast of Friday October 5th. Numerical guidance from CMC on the afternoon of October 7th (the onset of the rain) was for 45 mm in 36 hours and 55 mm in 48 hours with rainfall rates of 1-2 mm/hr. in the periods of heaviest rain. The CMC model's forecast precipitation pattern showed as much rain east of the coast mountains as along the west coast. This is a normal occurrence and was recognized as such.

The NMC forecasts issued in the FOUS 76 message were for .95 in. (24mm) over the same period.

The PWC forecasts for rain were continued through Saturday and at 8:45 a.m. on Sunday, October 7th, a "heavy rain warning" was issued for a further 35-60 mm. The warning was continued Monday for additional rainfalls of up to 80 mm. The warning was issued at the onset of the heavy rains with up to 140 mm forecast. This was close to the 171 mm which fell on Squamish up until 7:00 p.m. October 8th.

RAINFALL ANALYSIS

Figure 5 shows rainfall amounts for October 7 and 8, 1984 for selected sites in southwestern B.C. Rainfall amounts recorded at Data Collection Platform (DCP) sites operated by B.C. Hydro are included in figure 6. These two figures show that heaviest precipitation during the period was concentrated in the Squamish area and central Vancouver Island. No rainfall records are available for the Lillooet river valley upstream from Pemberton. It is noted that rainfall amounts recorded at the DCP sites are compatible with those reported at manned sites.

An extreme value analysis of the one-day storm rainfalls indicates that, the storm had a return period of 5 years or less in the Pemberton-Squamish area. However, if the three-day rainfall is examined, the return period of the storm becomes more significant. The 119.8 mm at Pemberton and the 127.9 mm received at Alta Lake for October 7-9, 1984 results in the three-day storm having a return period of 20 years for these two sites. Squamish's three-day total was 180.2 mm but the return period remained low at 6.5 years.

Short term rainfall rates were not exceptional during the storm. Tipping bucket rain gauge (TBRG) charts were examined for Alta Lake, Squamish Airport and Pemberton. Return periods for extreme 1 hr-to 6 hr-storm rainfalls at Pemberton and Alta Lake all remained below 5 years. Rainfall rates at Squamish Airport were considerably higher than at the previously mentioned sites but were not thought exceptional (Too little data is available for an extreme value analysis).

FLOODING AND ITS IMPACT

Inland Water Directorate (IWD) of DOE reported floods occurred in the Meagher Creek area in the headwaters of the Lillooet River on October 8 followed by widespread flooding of the Lillooet River Valley the next day. The water levels in the Lillooet River were the highest since records began in 1914.

An estimated 175 houses were flooded in the Pemberton area, livestock were drowned, roads, raillines and bridges sustained heavy damage while many recreational vehicles were marooned or swept away at several provincial parks.

B.C. Water Resources reported that stream gauge levels on the Squamish River after the storm were the highest since continuous records began in 1955. Little flooding occurred in the town of Squamish due, it is thought, to the diking program carried out over the past few years. Upstream from Squamish, however, numerous road washouts and bridge failures occurred.

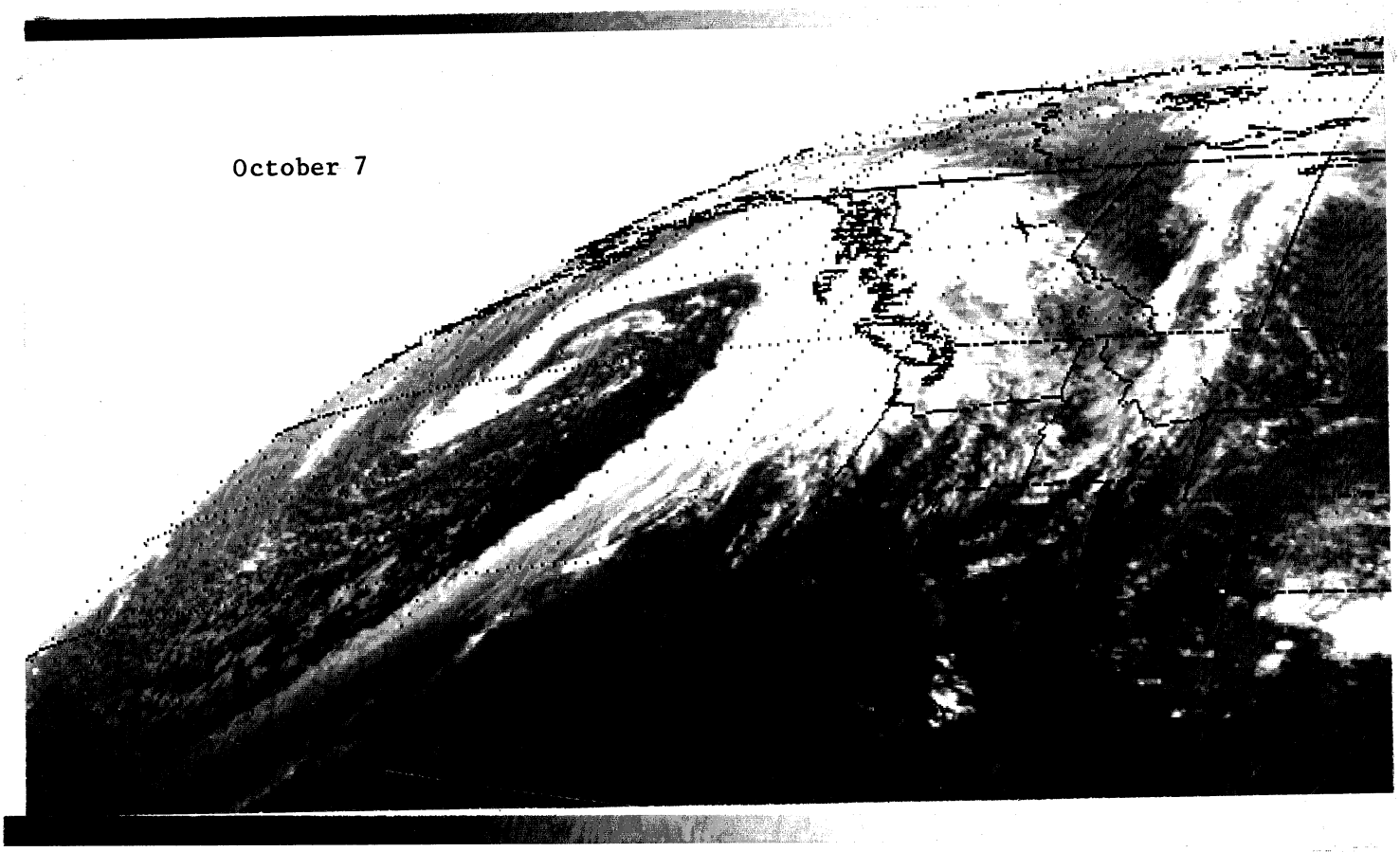
SUMMARY COMMENTS

The heavy rainfall in the Squamish-Pemberton area was a result of the persistence of the most active portion of a frontal system over the area. The frontal system itself was neither abnormally large or active. The rather unusual orientation of the frontal system in an almost north-south direction for most of the storm period may explain the extreme water levels on the Lillooet and Squamish rivers. One possible explanation is that with this frontal orientation, low-level winds would be channelled directly upvalley along these two river systems resulting in substantial orographically induced rainfall for both watersheds.

The circulation was fairly zonal as the system developed. The warm air associated was not subtropical in origin so that precipitable water values were not extreme. The very slow moving nature of the system was due to the very large wavelength of the trough behind it which did not move significantly until forced by another system from upstream.

As was shown earlier, short-term rainfall rates were not exceptional in the storm. The slow-moving nature of the frontal system led to persistent rainfall over the storm area and 3-day storm return periods of close to 20 years.

A more recent example of another slow-moving frontal system occurred November 23-24, 1984 when up to 100 mm fell in 24 hours. It is concluded that the speed of the system and not its intensity was the key to the heavy rainfalls and ensuing floods in the Thanksgiving Day storm. The orientation of the front may have determined the area of heaviest rainfalls.



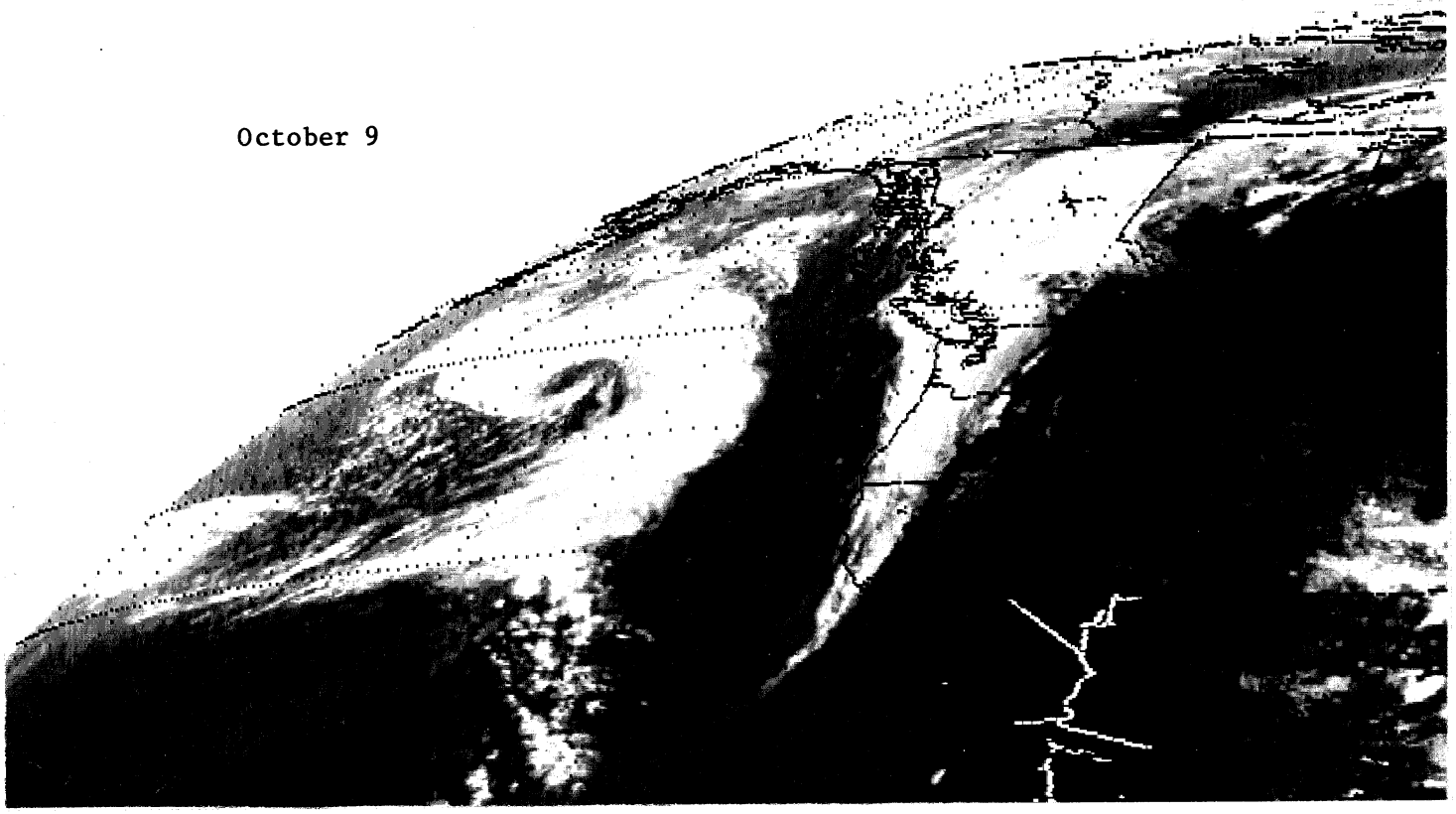


Figure 1. Satellite images at the beginning and end of the heavy rainfall event, 00Z Oct. 7 and 00Z Oct. 9.

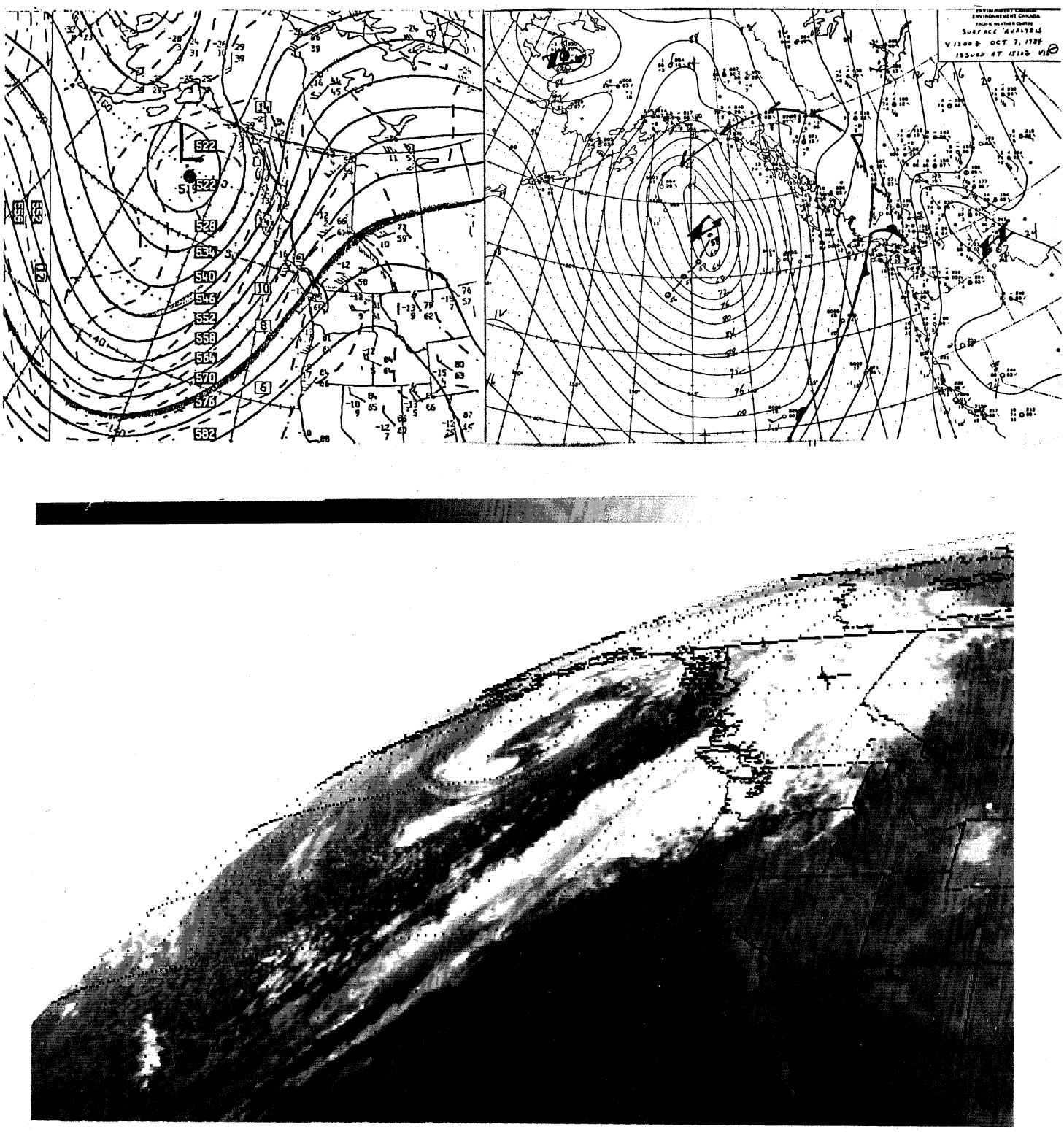


Figure 2. Satellite image, surface and 500 MB analyses at 12Z Oct. 7.

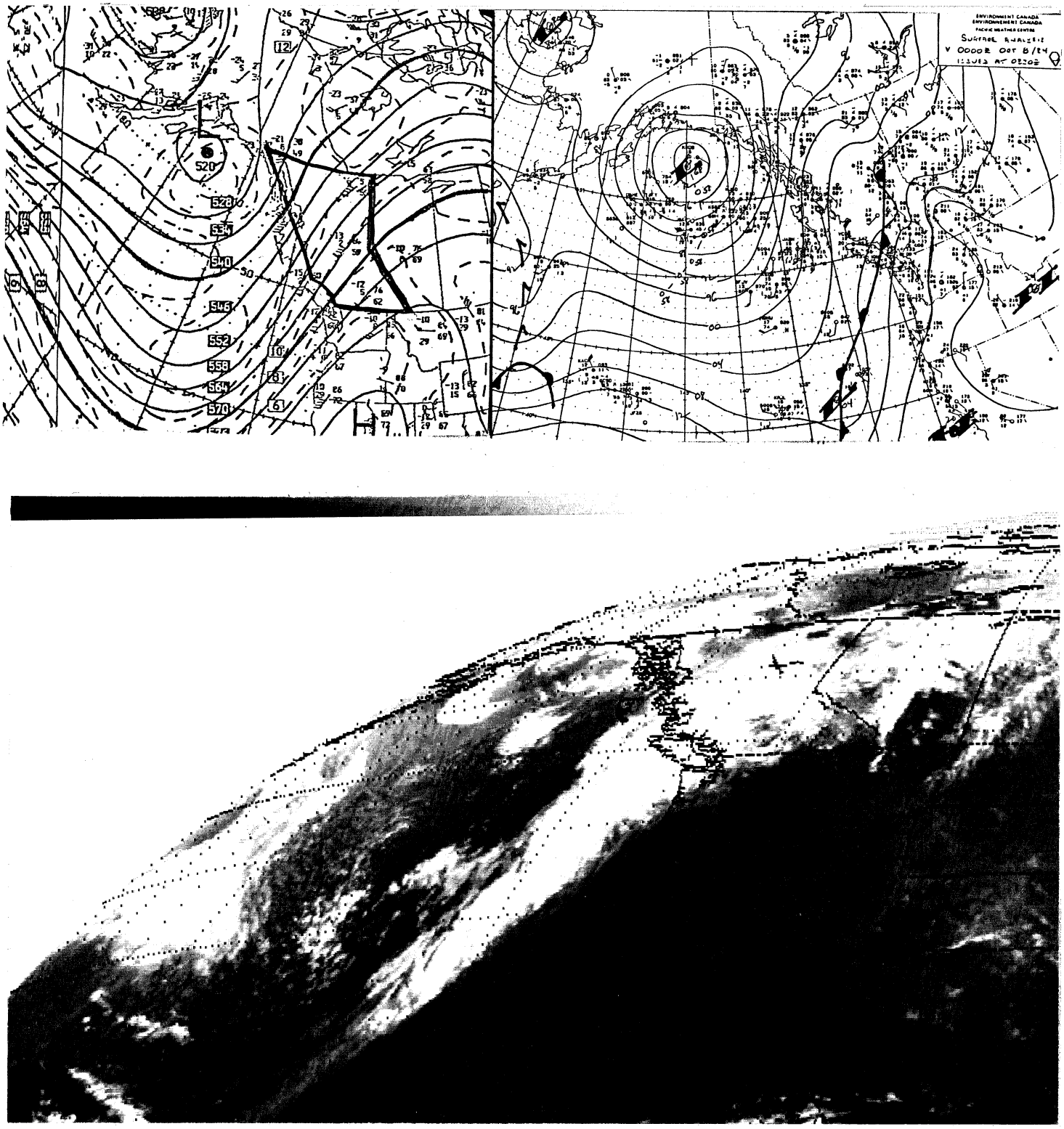
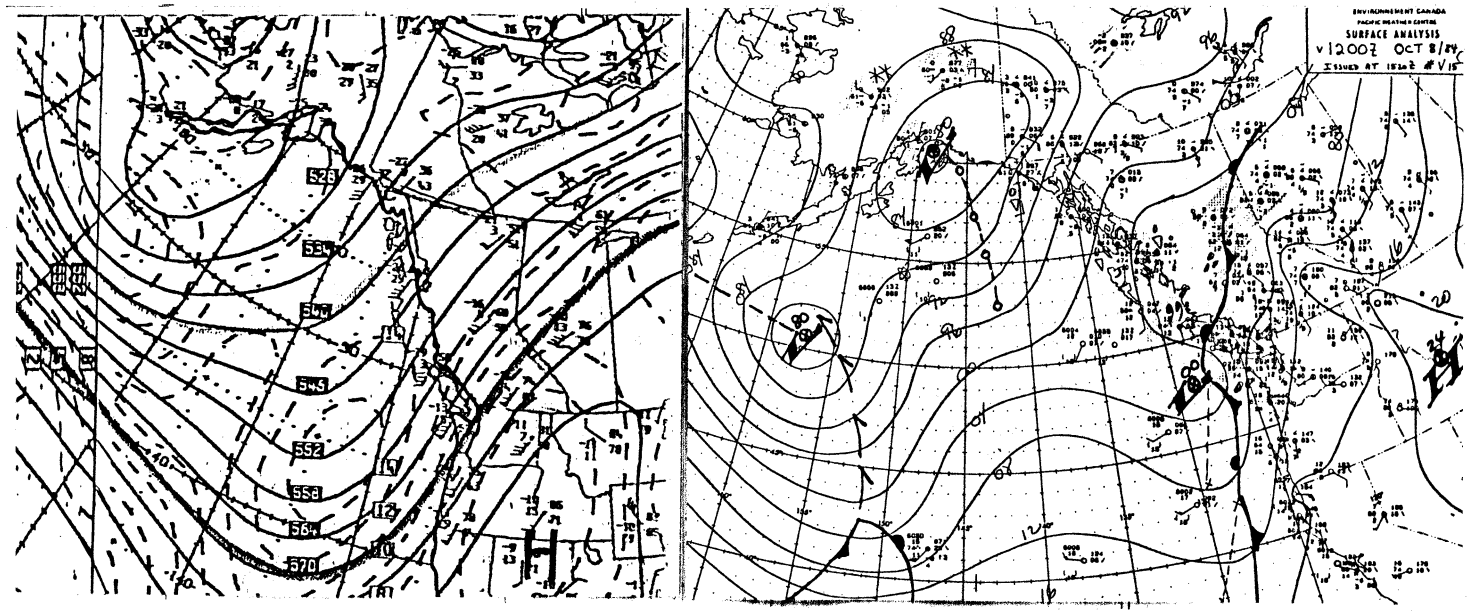


Figure 3. Satellite image, surface and 500MB analyses at 00Z Oct. 8.



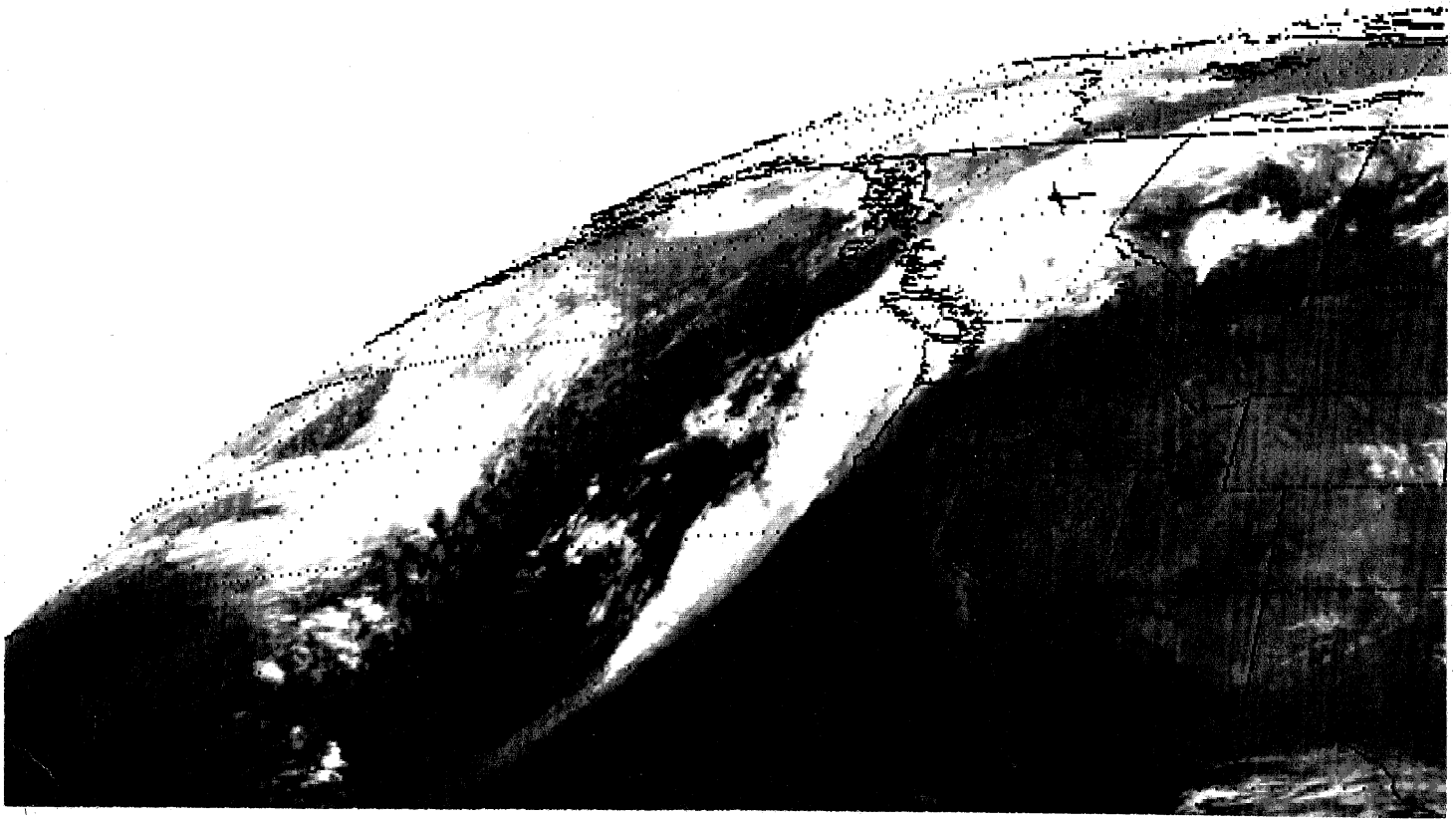
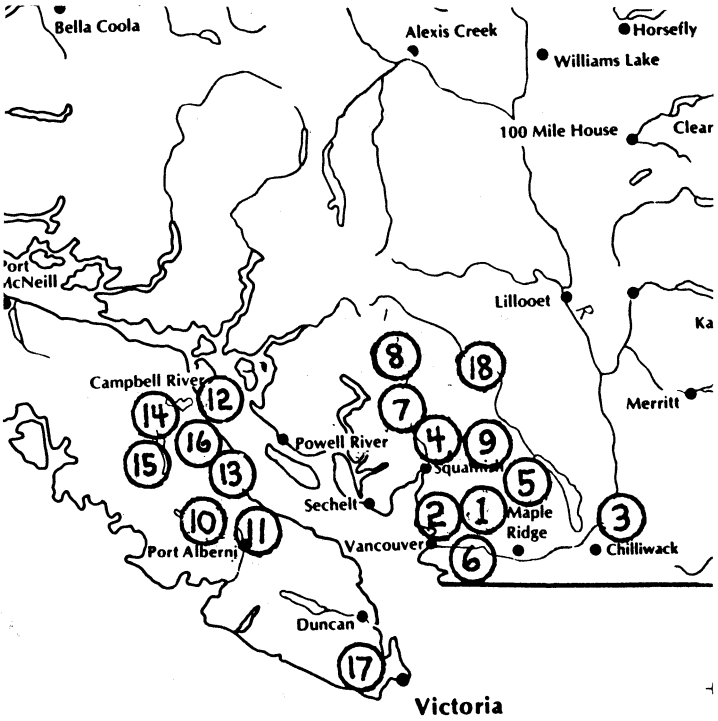


Figure 4. Satellite image, surface and 500MB analyses at 12Z Oct. 8.

	24 Hour Precipitation Amounts Ending At: 7 p.m. (except as noted) Sunday, Oct. 7, 1984	7 p.m. (except as noted) Monday, Oct. 8, 1984
Port Alberni	91.4 mm	54.8 mm
Alta Lake	46.5 mm	51.7 mm
Vancouver Harbour	37.8 mm	25.2 mm
Squamish Airport	101.2 mm	69.9 mm
Powell River	23.2 mm	22.2 mm
Vancouver Airport	30.6 mm (10 p.m.)	19.0 mm (10 p.m.)
Victoria Airport	9.9 mm (10 p.m.)	11.0 mm (10 p.m.)
Abbotsford	15.6 mm (10 p.m.)	32.5 mm (10 p.m.)
Comox	53.6 mm (10 p.m.)	17.0 mm (10 p.m.)
Pemberton BCFS	68.4 mm (7 a.m. Oct. 8)	23.6 mm (7 a.m. Oct. 9)
Squamish (Upper)	114.1 mm (7 a.m. Oct. 8)	50.7 mm (7 a.m. Oct. 9)
Port Mellon	132.2 mm (7 a.m. Oct. 8)	65.0 mm (7 a.m. Oct. 9)

Fig. 5. Rainfall recorded at AES observing sites.



Map #	DCP Site	Precipitation (mm)
1.	Alouette Forebay	-
2.	Coquitlam Forebay	-
3.	Jones Lake	6
4.	Cheakamus River	106
5.	Stave River	91
6.	Coquitlam River	-
7.	Elaho River	201
8.	Bridge River	-
9.	Gold Creek (Alouette)	87
10.	Cruickshank River (Comox)	121
11.	Elsie Lake (Comox)	173
12.	Strathcona Dam (Campbell)	74
13.	Comox Dam (Comox)	110
14.	Elk River (Campbell)	-
15.	Wolf River (Campbell)	192
16.	Eric Creek (Comox)	97

Fig. 6. Rainfall recorded (mm) during period
04Z Oct. 7 till 02Z Oct. 9, 1984,
at B.C. Hydro DCP Sites