PACIFIC REGION TECHNICAL NOTES

81-027

November 26, 1981

WINDSTORM OVER SOUTHWESTERN B.C. SATURDAY NOVEMBER 14, 1981

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INTRODUCTION

A windstorm which moved up the U.S. west coast and into Southwestern B.C. caused extensive power outages over Southern B.C. on November 14, 1981.

An examination of three-hourly synoptic data during the period indicates that the strong winds were due to the following factors: (1) a strong east-west pressure gradient; (2) an unusually high isallobaric gradient; (3) the funelling effect of the Olympics and the Cascade Range.

UPPER AIR FEATURES

During and prior to the storm, a large trough resided over the Eastern Pacific. Figure 1 illustrates the 540 dam for 11/12Z to 14/12Z. Figure 2(a) displays the upper air reports between 14/12Z to 17Z and Figure 2(b) for 14/21Z to 15/00Z. From the data, it appears that upper winds as high as 180 knots could have been realized just offshore northwestern California. These winds accounted for the rather fast movement of the weather system during the period.

The surface movement of the storm is indicated by Figure 3(a). Embedded in a strong westerly flow, a frontal wave 12/12Z developed a good cloud shield at 13/00Z (Figure 3(b)) as it moved into the major trough. It then deepened explosively to 958 mb (14/06Z) as it headed up the west coast and once crossing Vancouver Island, it desintegrated. The frontal system occluded over Southwestern Oregon at 14/00Z with the point of occlusion moving rapidly to eastern Idako by 14/12Z and the trowal extending in an arc across the lower mainland of B.C. - Figure 6(a).

A change of airmass followed the passage of the weather system. Figure 4 illustrates the change in airmass at Salem from 14/00Z to 15/00Z. (UIL was not used as the sounding for 15/00Z was not available and it was therefore assumed that the airmass in advance and especially following the frontal system over Salem would be similar to the airmass which would move over the lower mainland of B.C.) A fairly dry and stable airmass (θw 10-12°C) ahead of the system was replaced by a colder and slightly more unstable airmass (θw 7-8°C) which gave thundershowers to Astoria and Seattle and cumulonimbus clouds to many stations.

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SURFACE FEATURES

A series of three hourly surface maps were analysed, Figure 6(a) to 6(f) displays the surface pressure field with the isollobaric field for the last five figures. Using satellite imagery and surface data, the trowal was placed across Southerwestern B.C. at 12Z - Figure 6(b). The point of occlusion was over Idaho. From Figure 6, it can be seen that the pressure gradient to the south of YXX changed direction and doubled between 09Z and 21Z. Also impressive was the strong isallobaric gradient which developed as the colder airmass spread across the west coast.

The wind field was also analysed. Figure 5 displays the wind reports and the maximum hourly gusts where available. In advance of the storm, the winds were generally weak due to the blocking effect of the mountains over the region - Figure 5(a). By 21Z, a dramatic change occurred both in the wind speed and direction. Winds were now generally south to southeast 40 knots with gusts to 56 knots reported at Bellingham (just south of YXX) and 55 knots at Abbotsford (YXX). These strong winds extended well to the south, yet some areas closer to the storm and with flat terrain experienced much weaker winds. Vancouver's airport (YVR) highest gust was 43 knots at 19Z. Richmond, a suburb just south of the airport "was midly affected compared to Vancouver and Coquitlam" - Richmond Review Nov 18. Appendix A reveals the extent of the damage to other areas. Appendix B records the observed weather reports from Vancouver Harbour (WHC), YVR and YXX.

UNDERLYING CAUSE OF THE HIGH WINDS

In advance of the weather system, the terrain coupled with a cold airmass in the lower levels prevented the stronger winds from aloft to reach the surface. Following the passage of the trowal, the stable layer became eroded as colder and more unstable airmass moved over the region. The strong isallobaric field attests to the cold air advection and the instability resulted in a downward transport of momentum and therefore higher surface winds. (Note the 850 mb wind of 96 knots at Sle 14/12Z - Figure 4).

This downward transport took place south of the Olympics and was channelled northward along the western slopes of the Cascades (Figure 6(a)). As well, the surface pressure gradient changed from a N/S orientation at 09Z to an E/W orientation by 21Z thereby allowing for a strong N/S flow of air along the west side of the Cascades.

From the isobaric gradient, the gradient wind is approximately 60 knots. The contribution from the isallobaric field is about 27 knots. The vectorial addition of these two factors results in a south to south-west wind of about 85 knots. While the gradient wind barely approaches the maximum gusts reported at BLI and YXX, it would appear that an

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additional factor such as the isallobaric wind may be required to justify the high winds (RI 80).

PREDICTABILITY OF EVENT

Severe power outages such as that of the 14th rarely occur over B.C. The main reason is that most storms usually travel further offshore into the Charlottes and the intrusion of convectively unstable cold air passes repeatedly over areas such as the west coast of Vancouver Island and other sparsely populated areas (see last article Appendix A).

In this instance, the frontal system had occluded and this allowed the intrusion to occur over the lower mainland. Two other such storms were examined and bear a close resemblance. The 1962 "Columbus Day Windstorm" (LY 66) and the 1979 "Hood Canal Windstorm" (RE 80) both brought extensive damage to limited areas of the West Coast.

As is usual, the numerical products failed to catch the development of the storm. Possible reasons are outlined in SA 80. However, the forecast office, once noting the changing character of the frontal wave as it approached the coast, did issue marine warnings the day prior to the passage of the storm. The public forecast also specified that windy conditions would prevail. As is usual, no one anticipated the gusty conditions that would eventually develop following the storm. During the storm of 1979, the damage was mainly confined to Washington State.

While it may be possible to specify that high winds will occur, there is little ability to designate which area will be the most affected due to the interaction of topography. About the best we can hope for is to wait until we see sure signs of strong winds and then issue wind warnings and hopefully have two to four hours lead time.

RECOMMENDATIONS

Due to the infrequency of such storms, more resources should be spent in cataloguing such storms so as to build up knowledge as to the extremes of weather that can occur. With the rapidly changing level of experience, and the failure of NWP products to catch mesoscale phenomena such as this, it is imperative that more meteorological knowledge of the region be instantly available if we are to serve the public more effectively.

REFERENCES

LY 66 - R. Lynott and O. Cramer; "Detailed Analysis of the 1962 Columbus Day Windstorm in Oregon and Washington"; Feb. 1966, Monthly Weather Review.

RE 80 - R. Reed; "Destructive Winds Caused by an Orographically Induced Mesoscale Low"; Nov. 1980, Bulletin of the American Meteorological Society.

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RI 80 - B. Richwien; "Isollobaric Contribution to a Ship's Sinking"; Eighth Conference on Weather Forecasting and Analysis 1980.

SA 80 - F. Sanders and J. Gyakum; "Synoptic - Dynamic Climatology of the Bomb"; Oct. 1980, Monthly Weather Review.

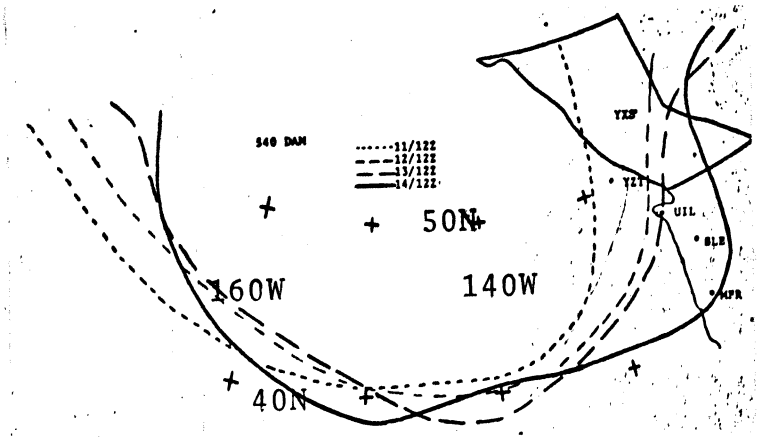


Fig.1 Upper trof as outlined by the 540 dam.

Fig. 2a,b Upper Air wind reports off the west coast.

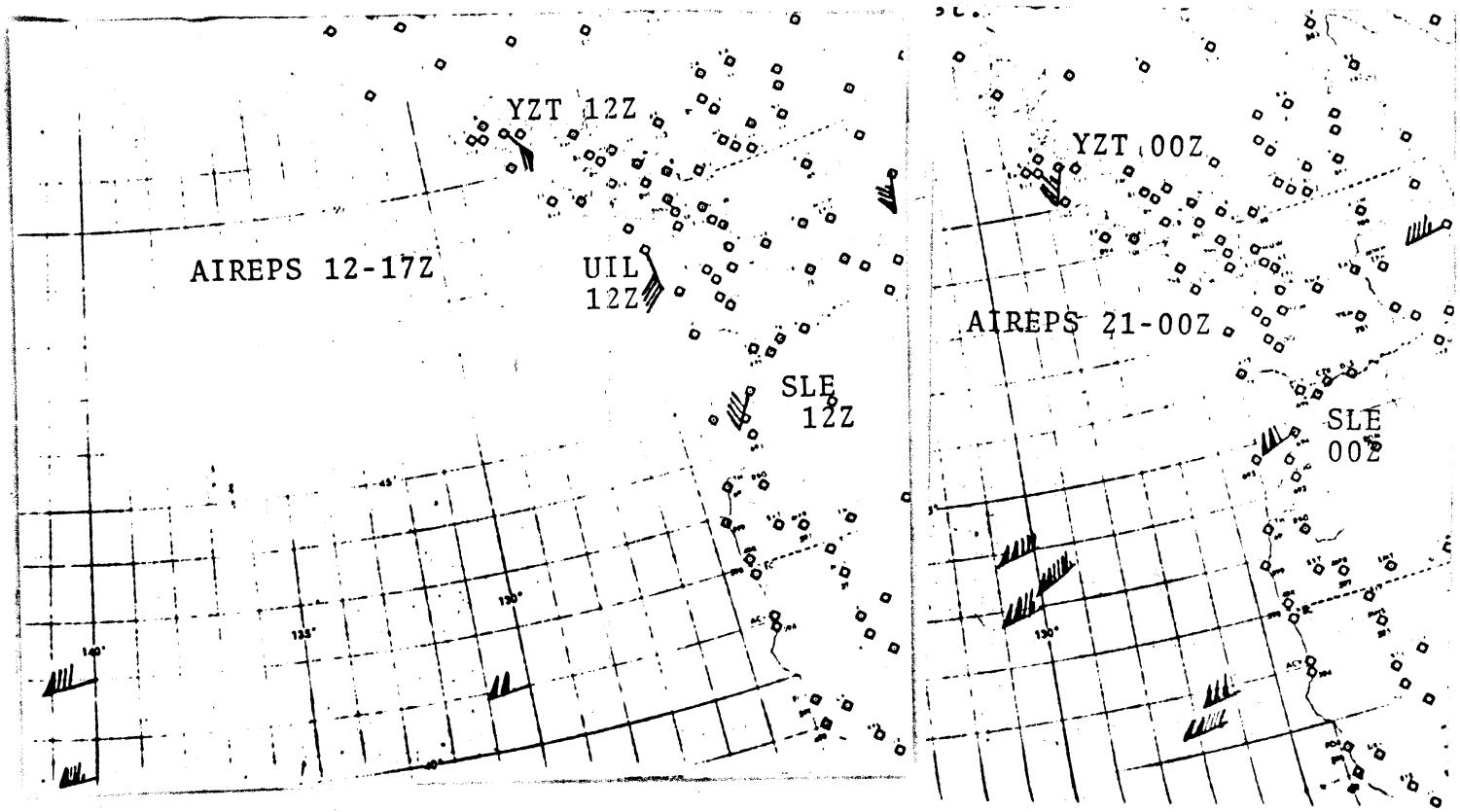


Fig. 3a. Movement of the surface low.

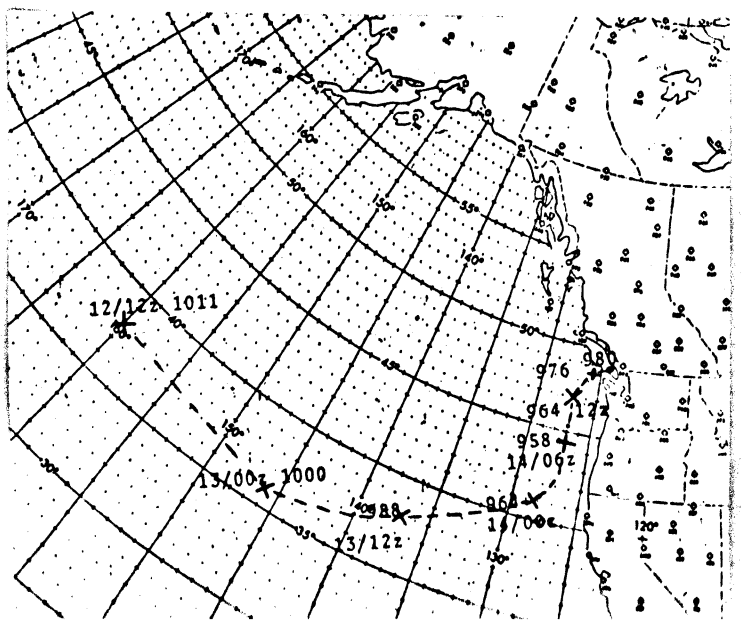
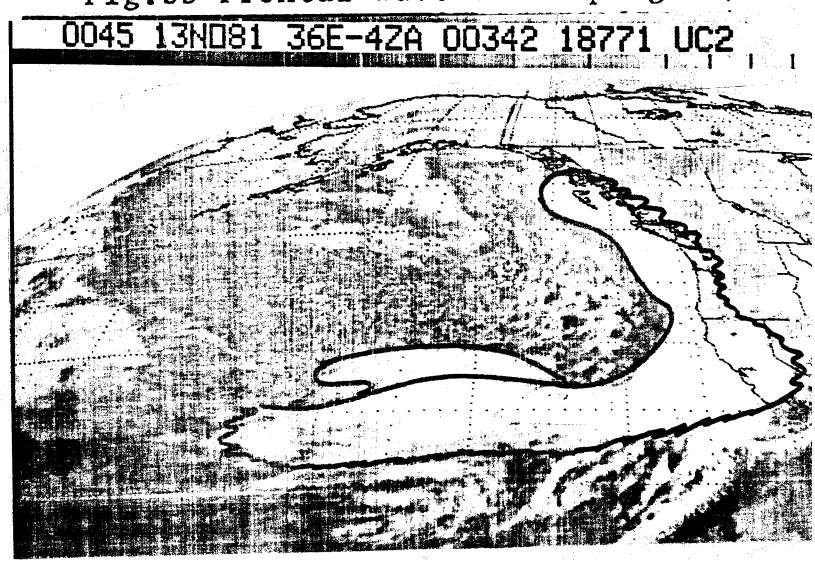


Fig.3b Frontal wave developing 13/00z.



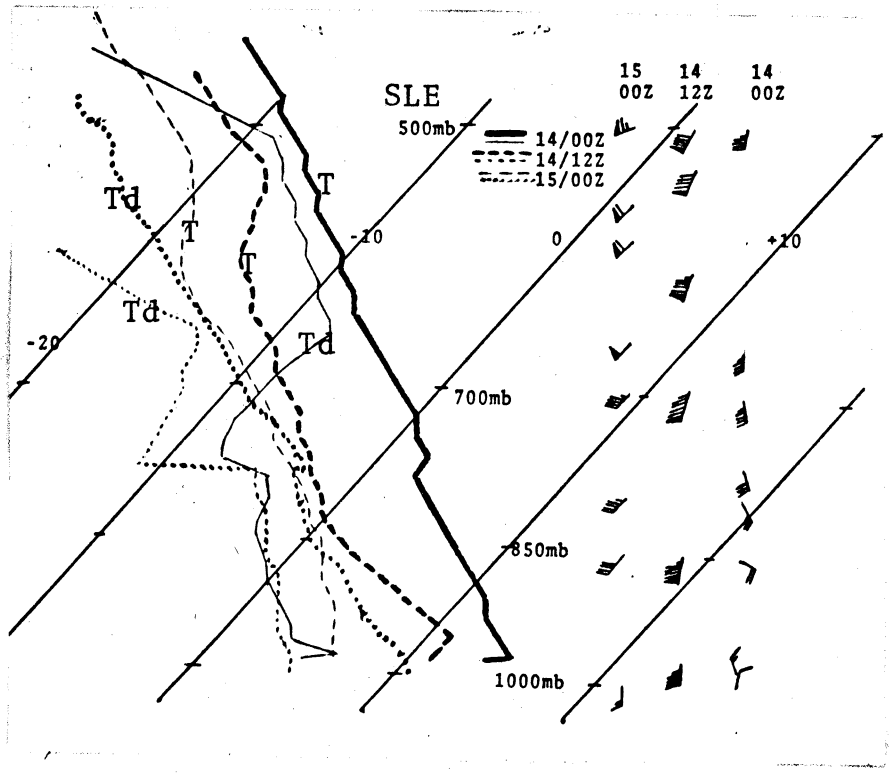
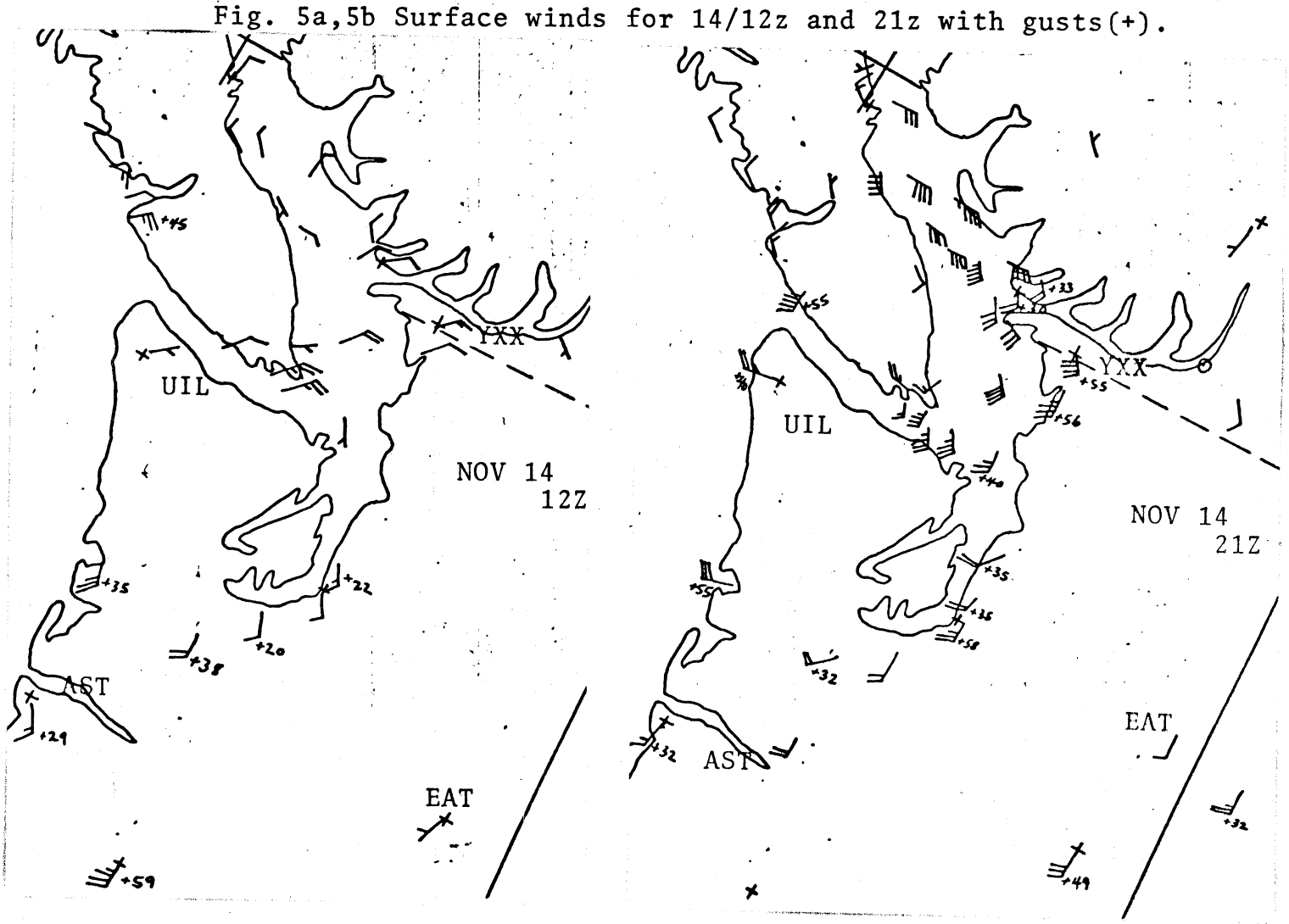


Fig.4 Sounding for Salem(T and Td).

Fig. 5a,5b Surface winds for 14/12z and 21z with gusts(+).



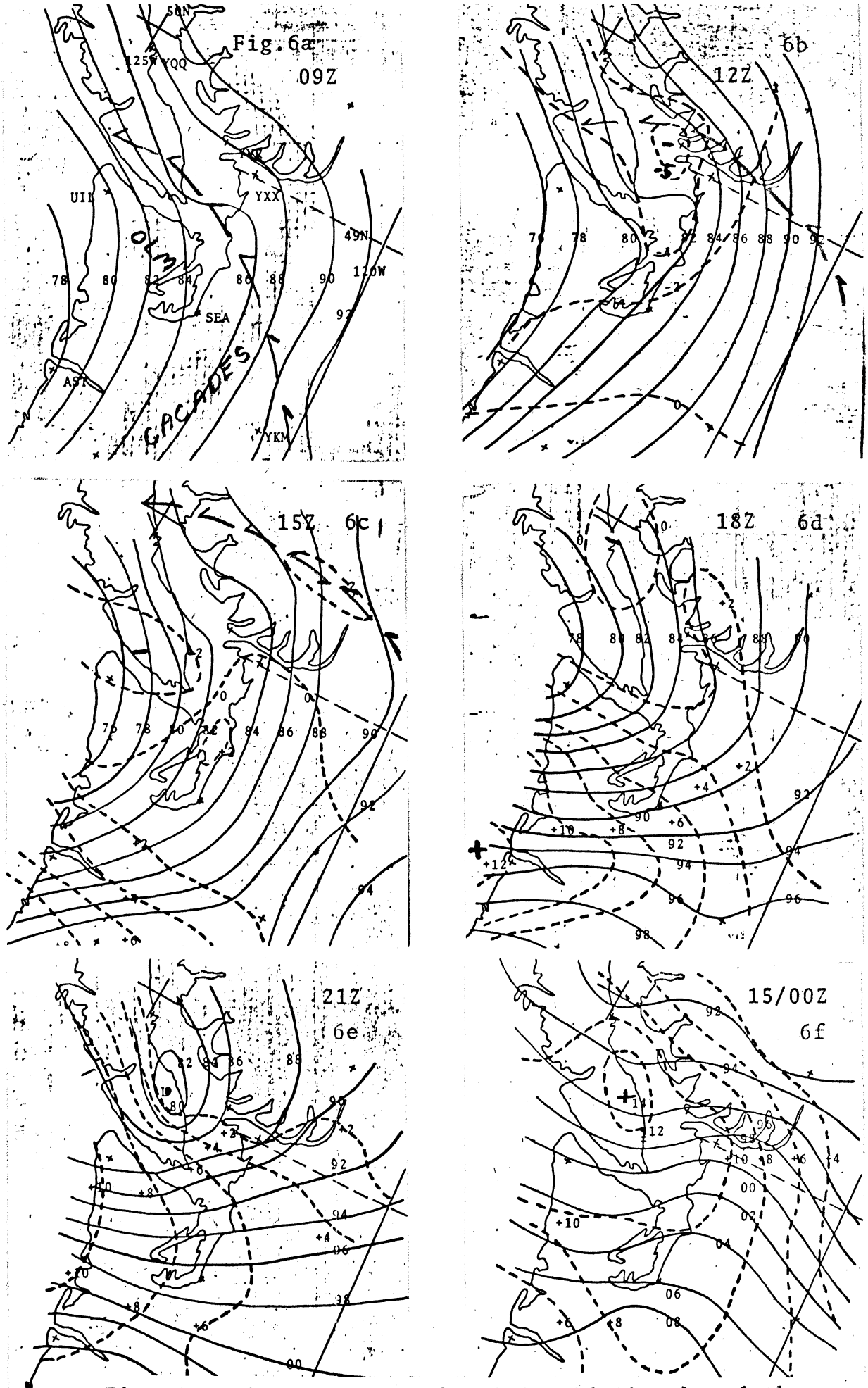


Fig. 6 Surface pressure fields(solid lines) and the isallobaric field(dashed lines).

Gale-force winds batter B.C. coast

Province News Services

Gale-force winds slammed into the Lower Mainland and Vancouver Island Saturday, killing a North Vancouver woman after cutting a bloody swath along the Pacific Northwest coast where at least five people were killed in Oregon and one in Washington.

Winds topple ship loader

Province News Services

B.C. maritime authorities had plenty to keep them busy Saturday as gale-force winds ripped through Lower Mainland waterways:

- At Neptune Terminals in North Vancouver, a 200-ton ship loader filled with coal toppled, causing extensive damage to the dock. Officials there said repairs would likely cost in excess of $1 million, although an accurate estimate would not be reached until early in the week.
- A flotilla of 15 small pleasure craft moored at Port Moody broke free and began floating out Burrard Inlet, heading for open sea.
- Two deep-sea vessels began dragging their anchors and had to be repositioned and secured at double anchor. The Greek-registered Scan Trio Arrow, in the inner harbor, and the Japan-registered Central, waiting for a berth in the outer harbor in English Bay, both dragged their anchors about a quarter-mile

Storms killed 11, cost $50 million

Associated Press

SEATTLE — Windstorms that hit the U.S. Pacific Northwest last weekend, toppling trees, smashing boats and marinas and claiming at least 11 lives, caused at least $50 million damage in Oregon and Washington, spokesmen for the insurance industry estimated Tuesday.

Insurance companies and adjusters said the storms did $25 million damage to insured property in each state, reported Cindy Laue, a spokesman for the Seattle regional office of the Insurance Information Institute, a national organization.

"Boats and marinas got heavy damage and schools and gymnasiums had their roofs blown off," she said.

Scott Carpenter, institute regional manager, said earlier estimates were multiplied to reach the $50-million figure when boat and marina wreckage was calculated.

The storms raged through the U.S. Northwest coast from Friday night through Sunday, sometimes whipping up 145-kilometre-an-hour winds, and cut power to 850,000 businesses and homes in Northern California, 300,000 in Oregon and 250,000 in Washington.

On Tuesday, Puget Sound Power and Light Co., crews were still working to restore power to 5,600 customers.

The storm killed at least six people in Oregon and five in Washington, authorities said.

"Boats and marinas really got heavy damage and those figures are just coming in," Carpenter said.

The West Bay Marina in Olympia, Wash., suffered more than $1 million wind damage alone, he said.

The Evergreen Point floating bridge, one of two floating bridges linking Seattle with communities east of Lake Washington, suffered between $300,000 and $400,000 storm damage, said Larry Waite, bridge superintendent for the Washington department of transportation.

The pelting storms wiped out half of the bridge's wave deflectors, uprooted an anchor cable and forced replacement of two mechanical devices that control movement of the drawspan pontoons.

Wind damage to Washington state forests was estimated at $1.6 million.

Appendix A.

News reports from the Vancouver "PROVINCE"

Tired Hydro crews restore power

Province News Services

The lights are back on over most of B.C. following feverish overtime repair work by B.C. Hydro crews during the last three days.

"These guys were putting in a long time this weekend," said Hydro spokesman Flint Bondurant. "There's a lot of tired people out there."

An estimated 100,000 Hydro customers were plunged into darkness by the weekend storms. Some went as long as two days without power. Hydro manned the repair work with 150 linemen around the clock and every available independent contractor.

Bondurant could not say how much the repair work had cost Hydro. "The paper work has just piled up."

Power was expected to be returned by today to all but isolated houses where se-

Editorial Comment.

To save more than money

Silly as it might seem, we'd probably suffer less damage if we had more storms. To begin with, the winds would naturally weed out the weak trees. And if we were sensible, we would take more precautions than we do now.

The weekend's blustery weather cut off electricity to as many as 100,000 B.C. Hydro customers. Yet the winds were not all that bad in most of the Lower Mainland. The worst recorded gusts reached 102 kph (64 mph) at Abbotsford on Saturday.

No major transmission line was brought down because Hydro keeps its main rights-of-way well cleared. Broken branches caused most of the trouble by falling on local distribution lines. Since strong winds are inevitable from time to time, the prudent thing to do would be to trim trees more rigorously.

One wonders perhaps whether Hydro finds it more cost-effective to fix power lines after our infrequent storms rather than spending a lot of time clearing trees.

But falling trees and limbs can do far more than damage power lines. They can flatten houses and kill people. And in many cases that may involve local authorities and homeowners in the responsibility as well as Hydro.

APPENDIX B

AVIATION REPORTS (0800Z NOV 14 – 0700Z NOV 15)

VANCOUVER AIRPORT

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 15 7  YVR SA 0700 20 SCT M50 BKN 70 BKN 15RW-- 107/9/5/1306/985/CF1SC6SC2
 15 6  YVR SA 0600 45 SCT 70 SCT E120 BKN 15 098/10/5/1510/982/SC2AC3AC4
 15 5  YVR SA 0500 45 SCT 70 SCT E120 BKN 15 090/10/5/1512G18/980/
 15 4  YVR SA 0400 50 SCT M110 BKN 15 071/10/5/1614G21/974/SC3AC6 PRESRR
 15 3  YVR SA 0300 15 SCT M50 BKN 70 BKN 15 050/10/6/1620G25/968/CF1SC5HC3
 15 2  YVR SA 0200 15 SCT 50 SCT M70 BKN 15 027/11/6/1719G27/961/CF1SC3AC5
 15 1  YVR SA 0100 15 SCT 45 SCT M70 BKN 15 997/11/7/1720G27/952/CF1SC3HC5
 15 0  YVR SA 0000 20 SCT 45 SCT M70 BKN 120 BKN 15 963/11/7/1719G30/942/
 1423  YVR SA 2300 20 SCT E45 BKN 90 BKN 10 936/11/8/1620G29/934/CF2SC4HC3
 1422  YVR SA 2200 16 SCT 35 SCT E90 BKN 10 900/11/7/1426G35/924/SF2SC3AC4
 1421  YVR SP 2142 16 SCT E30 BKN 90 BKN 10 1424G32 SF2SC5AC2=
 1421  YVR SA 2100 12 SCT M48 BKN 90 OVC 6RW-F 862/11/8/1320G30/912/
 1420  YVR SA 2040 16 SCT 30 SCT M68 BKN 120 OVC 6RW-F 847/11/7/1328G41/
 1419  YVR SP 1940 16 SCT 30 SCT M68 BKN 120 OVC 7RW- 1229G43 SF2SC3AC3AC2=
 1419  YVR SA 1900 16 SCT M28 BKN 70 OVC 10RW-- 847/11/7/1027G34/908/
 1418  YVR SA 1800 16 SCT M34 BKN 50 OVC 8RW-- 847/9/7/0820G29/908/
 1417  YVR SP 1734 9 SCT M34 BKN 45 OVC 10RW-- 0718G33 SF1SC8SC1=
 1417  YVR SA 1700 6 SCT E30 OVC 4RW-F 840/9/7/0820G30/906/SF5SC5  TCU
 1416  YVR SP 1634 6 SCT M43 BKN 70 OVC 5RW-F 0818G26 SF3SC6AC1 TCU EMBDD=
 1416  YVR RS 1600 M48 BKN 90 OVC 12RW- 834/10/6/0820G26/904/SC6AC4 ?26XX?=
 1415  YVR RS 1500 40 SCT E80 OVC 15 825/10/5/0711/901/SC4HC6 705 ?84XX?=
 1414  YVR RS 1400 E40 BKN 80 OVC 7RW- 827/10/5/0912/902/SC6AC4 =
 1413  YVR SA 1300 40 SCT E90 BKN 12 823/8/6/0710/901/SC3AC6 ?3799?=
 1412  YVR SA 1200 40 SCT E90 BKN 12 830/10/6/0711/903/SC4HC5 751 ?6599?=
 1411  YVR RS 1100 40 SCT E90 OVC 12 847/9/6/0712/908/SC5AC5 PRESFR ?21XX?=
 1410  YVR SA 1000 E35 BKN 70 OVC 10R- 866/9/7/0506/914/SC7AC3 ?85XX?=
 14 9  YVR SA 0900 E35 BKN 100 OVC 10R- 881/9/6/0000/918/SC6AC4 818 ?53XX?=
 14 8  YVR SA 0800 E35 BKN 800VC 10RW- 887/9/6/0902/920/SC6AC4 ?38XX?=
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VANCOUVER HARBOUR

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 15 3  WHC SA 0300 30 SCT E70 BKN 15+ 051/10/6/1706G13/968/SC2AC7 PRESRR
 15 2  WHC SA 0200 30 SCT E70 BKN 15+ 026/11/6/1905G12/961/SC4AC5 PRESRR
 15 1  WHC SA 0100 30 SCT E70 BKN 15+ 996/11/7/2006G12/952/SC3AC6  PRESRR
 15 0  WHC SA 0000 14 SCT 30 SCT E80 BKN 140 BKN 15 963/11/8/1807G14/942/
 1423  WHC SA 2300 14 SCT 30 SCT E75 BKN 110 BKN 15 936/10/8/1510G18/934/
 1422  WHC RS 2200 12 SCT 30 SCT E75 BKN 12 900/11/8/1518G33/923/CF1CF5AC4
 1421  WHC SA 2100 12 SCT E30 OVC 3RW 871/10/7/1319G27/915/SF1SC9  PK GUST
 1420  WHC SA 2000 12 SCT E30 OVC 8RW- 861/10/7/1019G27/912/SF2SC9 ?14XX?=
 1419  WHC SA 1900 14 SCT E32 OVC 7RW- 860/10/7/0920G27/912/SF2SC9 ?72XX?=
 1418  WHC SA 1800 14 SCT E32 OVC 12RW- 852/10/8/0817G25/909/SF1SC9  PK
 1417  WHC SA 1700 E18 BKN  35 OVC 3RWF 847/11/9/0814G20/908/CF9SC1 ?67XX?=
 1416  WHC SA 1600 E45 BKN 80 OVC 15RW- 840/11/8/0913/906/SC9AC1 ?55XX?=
 1415  WHC SA 1500 E50 OVC 15+RW- 829/11/7/0810/903/SC10 510 ?57XX?=
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ABBOTSFORD

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 15 7  YXX SA 0700 M35 BKN 70 OVC 20 106/9/5/1910/934/SC7HC3 =
 15 6  YXX SA 0600 15 SCT E30 BKN 50 OVC 15RW-- 098/9/6/1912/982/CF1SC5SC4
 15 5  YXX RS 0500 15 SCT E30 BKN 50 OVC 15 089/9/6/1913G18/979/CF1SC6SC3 =
 15 4  YXX SA 0400 15 SCT M30 OVC 12RW- 077/9/6/1916G21/976/CF1SC9 =
 15 3  YXX SA 0300 14 SCT M26 OVC 15RW- 059/9/7/1912/970/SF2SC8 173 =
 15 2  YXX RS 0200 6 SCT E14 BKN 30 OVC 10RW- 040/9/7/1817G23/964/
 15 1  YXX RS 0100 6 SCT E14 OVC 3RW-F 016/9/8/1822G29/957/SF4SF6 PRESRR =
 15 0  YXX RS 0000 8 SCT E14 BKN 27 OVC 5RW-F 986/10/8/1823/948/SF4SF2SC4
 1423  YXX RS 2300 9 SCT E13 BKN 25 OVC 21/2RWF 960/9/8/1917G25/941/
 1422  YXX RS 2200 15 SCT 23 SCT E40 OVC 15RW- 914/12/6/1636G50/928/
 1421  YXX SA 2100 14 SCT 21 SCT 37 SCT E48 OVC 20 878/13/6/1638G55/917/
 1420  YXX SA 2000 15 SCT E33 BKN 50 OVC 20 865/12/6/1527G45/913/CF2CU6SC2
 1419  YXX RS 1900 10 SCT 18 SCT E32 BKN 45 OVC 15RW-- 865/11/6/1418G34/
 1418  YXX SA 1800 8 SCT E26 BKN 38 OVC 10RW- 863/8/6/1105/913/CF3CU6SC1
 1417  YXX SP 1740 9 SCT E28 BKN 40 OVC 10RW- 0806 CF2CU5SC3=
 1417  YXX SA 1700 15 SCT E34 BKN 70 OVC 12RW- 850/8/6/0908/909/CF2SC6AC2
 1416  YXX SA 1600 E40 BKN 75 OVC 15RW- 846/9/5/1007/907/SC8AC2  VSBY N 20
 1415  YXX SA 1500 E40 BKN 75 BKN 20RW- 836/9/4/0706/904/SC7AC2  SML BRK
 1414  YXX RS 1400 40 SCT E75 OVC 20RW- 834/9/5/0810G17/904/SC5AC5 =
 1413  YXX SA 1300 45 SCT M75 BKN 20 831/8/5/0404/903/SC3AC6 SML BRKS =
 1412  YXX SA 1200 45 SCT E80 BKN 20 836/8/6/0613G18/904/SC2AC6 627 =
 1411  YXX SP 1132 44 SCT 80 SCT 20 0612 SC2HC2=
 1411  YXX SA 1100 M43 BKN 80 OVC 15R- 849/8/7/0709/909/SC7AS3  MOON DMLY
 1410  YXX SA 1000 M40 BKN 80 OVC 10R- 863/9/6/0613/913/SC8AC2 =
 14 9  YXX SA 0900 M41 BKN 80 OVC 12R- 864/10/5/0210/912/SC8AC2 827 =
 14 8  YXX RS 0800 M40 BKN 80 OVC 12R- 876/11/4/0611/916/SC7AC3 =
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