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AN EXAMPLE OF RADIO DUCTING FROM THE ABBOTSFORD RADAR

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INTRODUCTION

During night time hours, forecasters must rely more and more on remote sensing to determine the state of the atmosphere. This note examines a radar display which suddenly picked up what appeared to be a case of unexplained convective activity.

SYNOPTIC SITUATION

Fig. 1 shows the 500mb circulation pattern. Over Vancouver Island, we can see a trof moving southeastwards followed by an upper ridge giving northeasterlies to northern Vancouver Island. The surface map indicated a building surface ridge from the north. The TIROS 1131z Sat. picture (Fig. 2) shows some activity near the Olympic Peninsula with no visible activity over Vancouver Island.

The radar charts for 0820Z, 0850Z (Fig. 3) indicated an area of convective activity near the Olympics which was confirmed by the satellite picture; however, the picture failed to explain a growing area of echoes over Vancouver Island. As well this mysterious area persisted well past 1450Z (Fig. 3c). Yet surface observations (Fig. 4) showed only clear to thin scattered sky conditions. The only possible explanation is a situation of superrefraction.

RADAR AND SUPERREFRACTION

Under normal atmospheric conditions, there is some bending of the radar waves. However, this refraction can be increased by abnormal conditions in the atmosphere and by the use of shorter wavelengths. This note examines a case of severe refraction brought about by unusual atmospheric conditions.

The formula giving the radio refractive index n as a function of atmospheric pressure P in millibars, temperature T in degrees absolute, and partial pressure e of water vapour in millibars is

$$(n-1) \times 10^6 = \frac{79}{T} \left(p - \frac{e}{7} + \frac{4800e}{T} \right) \quad (\text{Booker})$$

or, $N = (n-1)10^6$ where N = index of refraction

If $n = 1.000500$, then $N = 500$

A radio duct will usually result when vertical temperature and moisture gradients are such as to produce an index of refraction lapse rate of greater than 48N units per 1000 feet (Glossary of Meteorology). The resulting curvature will cause the radio waves to be greater than that of the earth. Thus, radar waves that leave the antenna at angles near the horizon may be trapped within the layer.

Fig. 5 displays the radiosonde sounding for 00Z and 12Z on August 8, 1980 for Port Hardy and Quillayute. From the results stated by Booker, a necessary condition for the existence of a duct is

- (a) a temperature inversion exceeding about 5°F. per 100ft. within a few thousand feet of the earth's surface;
- (b) lapse rate exceeding about $\frac{1}{2}$ g. per Kg. per 100ft. within a few thousand feet of the earth's surface.

Fig. 5 shows that a strong inversion developed between 00Z and 12Z over the Port Hardy area. As well, a good gradient of temperature developed close to the surface. The requirement for a radar beam at low angles is also satisfied as the anomalous echoes are about 80 to 120Kms away at a height of only 1.5Km. Using $P \approx 1000\text{mbs}$, $\epsilon \approx 12\text{mbs}$, and $T \approx 283^\circ\text{K}$, $N \approx 330$ over a depth of 30mbs (depth of inversion) and generously satisfies the requirement of $N=48$ units over 1000 feet.

Fig. 6 displays the topography over the east side of Vancouver Island which the radar return closely duplicates.

CONCLUSION

While radar returns are generally correct, there will be occasion such as this one where radar echoes could result in a bad interpretation of the state of the atmosphere. Over the mountainous areas of B.C. there is a strong need to have the radar beam aimed at a level high enough to miss most mountain peaks yet low enough to still give a reasonable estimate of precipitation rates. Strong inversion such as the one discussed will necessitate good techniques if radar precipitation networks are to be of any value. On the other hand, one possible benefit of anomalous propagation as in this example is the possible generation of the probable heights of inversions using known heights of the topography in the area of echo return. This, coupled with mesoscale modelling, would give us an insight in the atmospheric state in areas lacking data.

REFERENCE

- Booker, H.G. - Meteorological Aspects of Propagation Problems;
Compendium of Meteorology.

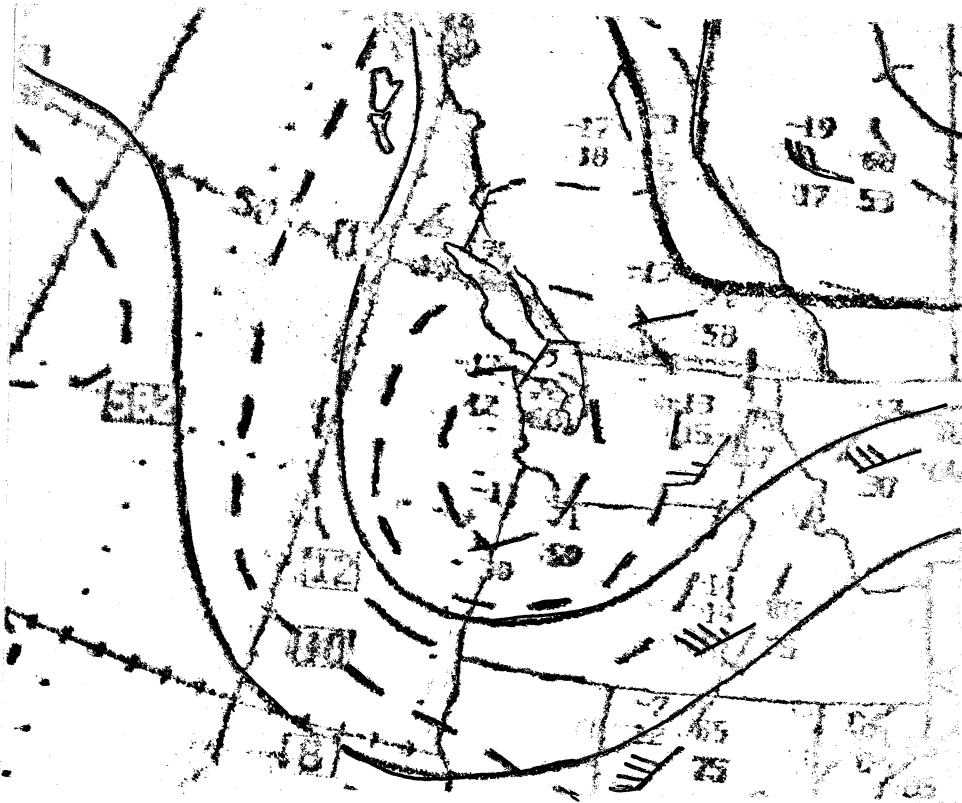


Fig. 1: 500mb circulation over Vancouver Is. 12z Aug.8 1980.

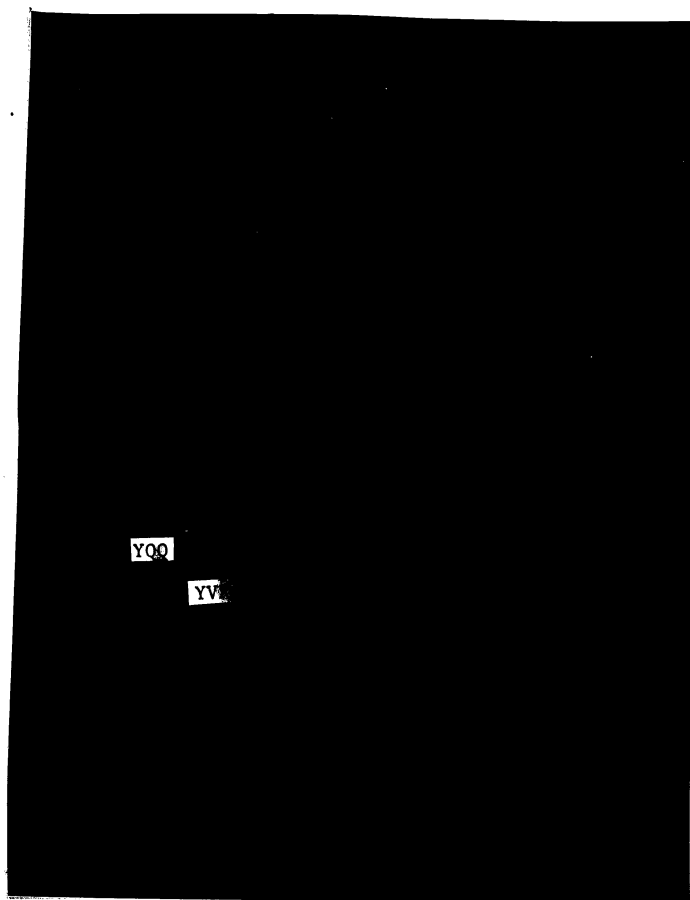


Fig. 2: Tiros IR picture for 1131z Aug. 8 1980. Note convective activity over western Wash. State.

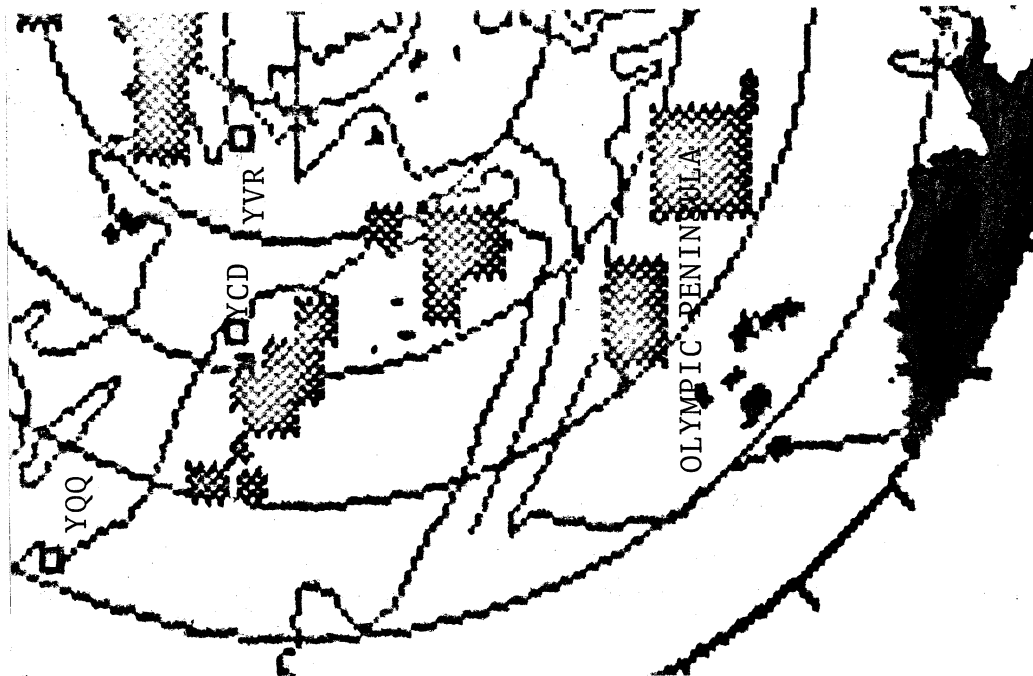


Fig. 3a: Radar display for 0820z Aug. 8. (note convective activity over the Olympic Peninsula)

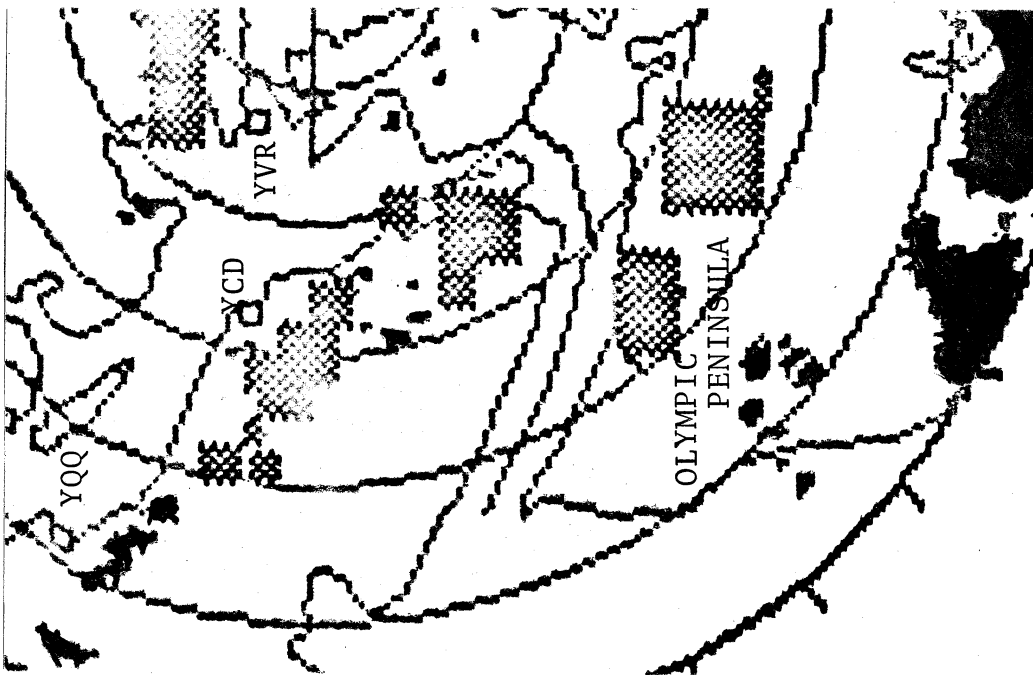


Fig. 3b: Radar display for 0850z Aug. 8. (note large increase in echoes near YQQ)

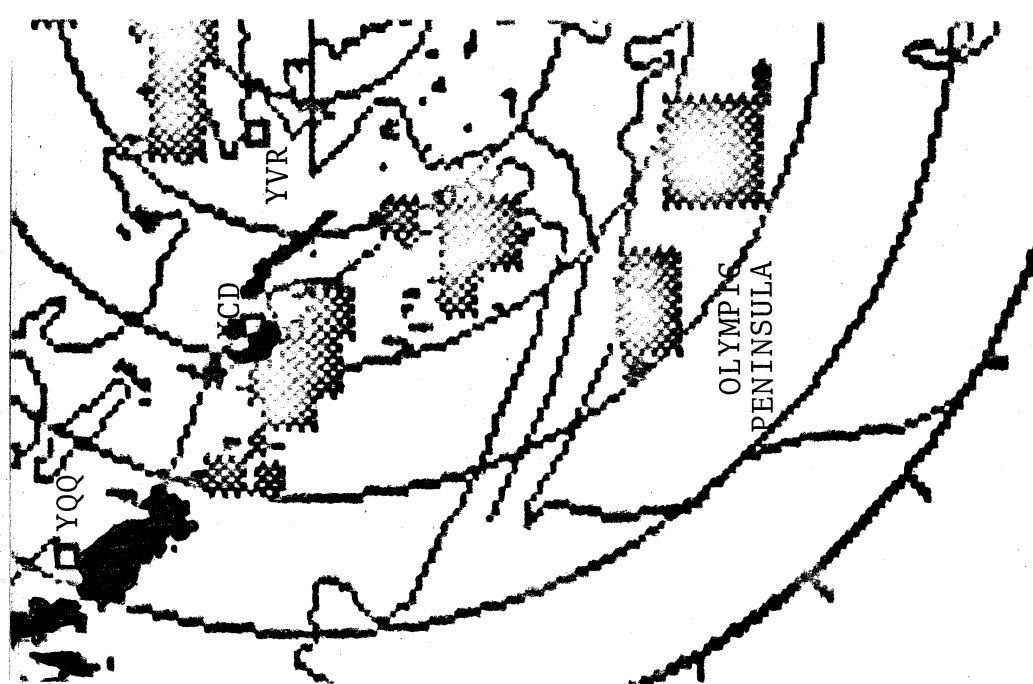


Fig. 3c: Radar display for 1450z.

0817	YQQ	SA	1700	CLR	20	212/16/11/3511/015/	=
0816	YQQ	SA	1600	CLR	20	209/16/11/3512/015/	=
0815	YQQ	SA	1500	CLR	20	206/15/10/3408/014/	117 =
0814	YQQ	SA	1400	CLR	20	202/13/9/3004/013/	=
0813	YQQ	SA	1300	250	-SCT	20	195/13/9/3106/011/CI =
0812	YQQ	SA	1200	CLR	20	189/13/8/3308/009/	210 =
0811	YQQ	SA	1100	CLR	20	186/14/9/3105/008/	=
0810	YQQ	SA	1000	CLR	20	182/14/9/3306/007/	=
0809	YQQ	SA	0900	CLR	20	179/15/9/3205/006/	209 =
0808	YQQ	SA	0800	300	-SCT	20	177/16/10/3306/005/CI =

Fig. 4: Comox aviation reports for the morning of Aug. 8.

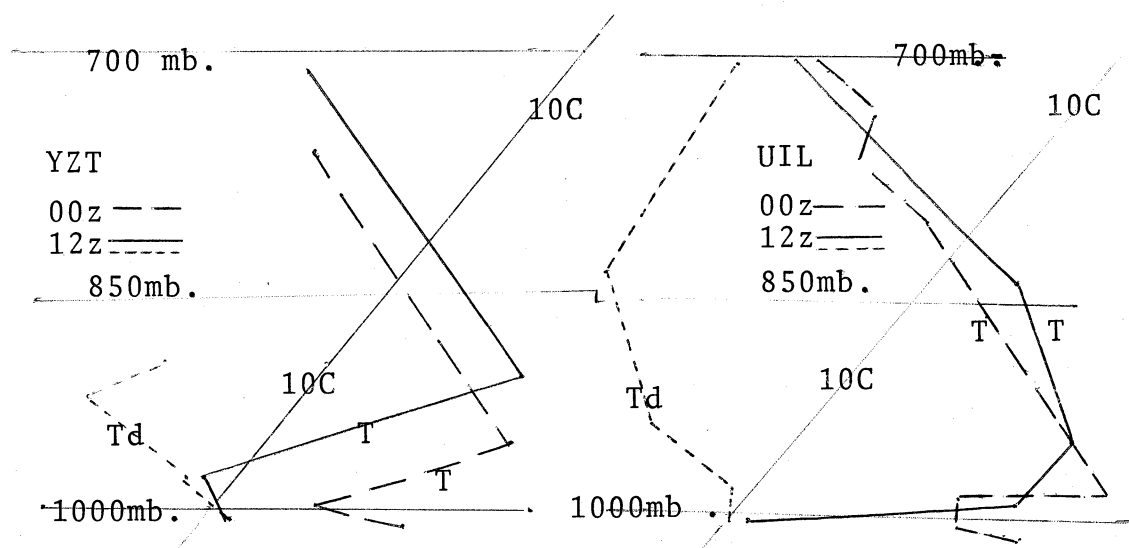


Fig.5:vertical sounding for Port Hardy and Quillayute for 00,12z Aug.8.

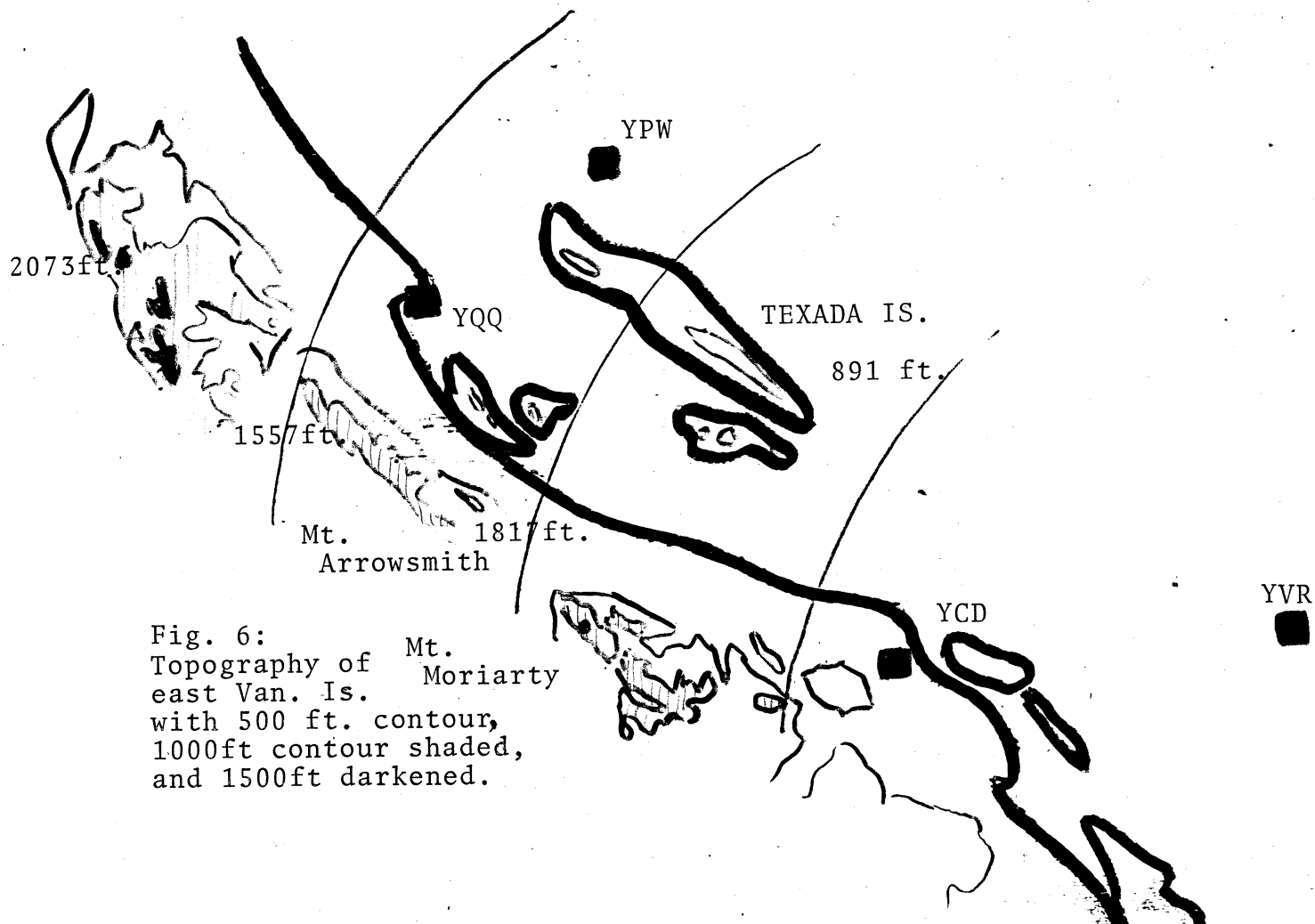


Fig. 6:
Topography of Mt. Moriarty
east Van. Is.
with 500 ft. contour,
1000ft contour shaded,
and 1500ft darkened.