PACIFIC REGION TECHNICAL NOTES

79-30
November 9, 1979

A Rain Shadow Exposed by the Abbotsford Radar

H.T. Beal, Meteorologist
Pacific Weather Centre, Vancouver

INTRODUCTION

It is well known that the leeward slopes of most higher mountain ranges are usually quite dry, being said to be in the "rain shadow" of the mountain range. This phenomena is largely due to the Foehn effect which often leads to the dissolution of the precipitation and/or cloud leeward of the mountain range.

The Foehn (chinook) winds are dry strong downslope winds. These winds generally occur between the mountain divide and the first leeside trough of the standing wave.

The "rain shadow" effect is obvious in certain geographical areas. The phenomena may be detected by differences in vegetation, precipitation and, on a more limited scale, by satellite imagery and radar "maps".

Last month, October 1979, the SCEPTRE-radar system at Abbotsford provided an exquisite illustration of the "rain shadow" leeward of the Olympic Mountains (northeast corner of Washington). This pictorial representation of the "rain shadow" affords us the opportunity to describe some pertinent features of the phenomena.

THE RADAR

Recently, the SCEPTRE-radar system became operational. The radar is located at Abbotsford and the display transmitted to the Pacific Weather Centre. The display is known as CAPPI (constant altitude plan position indicator). The radar-range is 240 km.

Figure 1 displays the area encompassed by the radar. The hatched areas are generated automatically when the scanning altitude is set for 1.5 km. At this altitude, the "blocked out" areas are mountain ranges obstructing the radar signals. The arrows with the attached numbers give the approximate location and elevation (km) of some significant mountain peaks.

The radar displays the precipitation, at some given altitude (normally 1.5 and 4 km), in terms of a shaded area. Four shades, from light gray to black, are used and correspond to four different precipitation ranges.

CLIMATOLOGY

In terms of precipitation, the mean annual amounts along the west coast are of the order of 150 cm. This amount varies considerably with terrain and doubles on the western slopes of significant mountain ranges. For sheltered locations, the amount may be reduced by half. For example, Victoria, favoured by Mother-Nature, receives roughly 65 cm per year.

SYNOPTIC PATTERN

On October 24, a substantial cyclone was situated off the Oregon coast (figure 3) with a major wave further east. Embedded in a vigorous southwest flow (refer to figures 5 and 6) the wave is tracking northeast. Further, the wave was delineated by an organized comma cloud configuration (figure 2). In addition, the surface charts confirmed an extensive rain area ahead of the frontal system, covering the south coast of B.C.

RAIN SHADOW

From figure 4, we note the extensive radar-generated precipitation map. The map is for 2100Z at an altitude of 1,5 km. The "rain shadow" area is explicit and persisted for about an hour prior to and after this time.

Note that the shadow region includes the greater Victoria area. Naturally, this is important to the forecaster, Victoria being a separate public forecast region as well as one of the larger urban centres.

Due to the mountainous terrain almost enclosing Abbotsford, any radar information must be treated cautiously and especially when interpreted over a minute area. Seeking corroborating evidence for the "rain shadow", we note that Victoria and Friday Harbour reported no rain at this time, but Whidbey Island had rain. This was unexpected as Whidbey Island is well within the shadow area delineated by the radar. Now, it appears reasonable that any radar returns for an area beyond a mountain range, which is located between the radar and the given area, should be suspect. Thus the most probable explanation for the discrepancy at Whidbey Island is that the mountain range south of Abbotsford extends just far enough west to run interference with the radar pulses to Whidbey. Therefore, the "rain shadow" area east of Whidbey Island may well be only a partial one.

CONCLUSIONS AND OBSERVATIONS

(1) A moist stable flow from the southwest of about sixty knots aloft will generate a "rain shadow" leeward of the Olympic Mountains. The area is roughly rectangular measuring 60 by 50 km and just includes the southern tip of Vancouver Island.

(2) Forecasts for the greater Victoria area should be cognizant of this effect if expected to persist for some time.

(3) Note that with the surface isobaric pattern, the surface winds tend to be east to southeast. But the upslope precipitation expected on the eastern slopes is effectively suppressed by the strong subsidence induced by the southwest flow at the higher levels.

(4) In general, the radar is quite useful in identifying "rain shadow" areas under varying atmospheric flows. In future, it may be of interest to catalogue the diverse shadows created under different conditions. Such an approach would help to "fine-tune" forecasts for the East Coast of Vancouver Island and Victoria. Furthermore, users requiring specialized forecasts, with emphasis on precipitation, would benefit.

(5) Lastly, a cautionary note, one must be alert when accepting radar information for those areas which have a significant mountain range interposed.

ACKNOWLEDGEMENT

The author gratefully acknowledges the time and support provided by the Pacific Weather Centre's ODIT unit for this technical note.

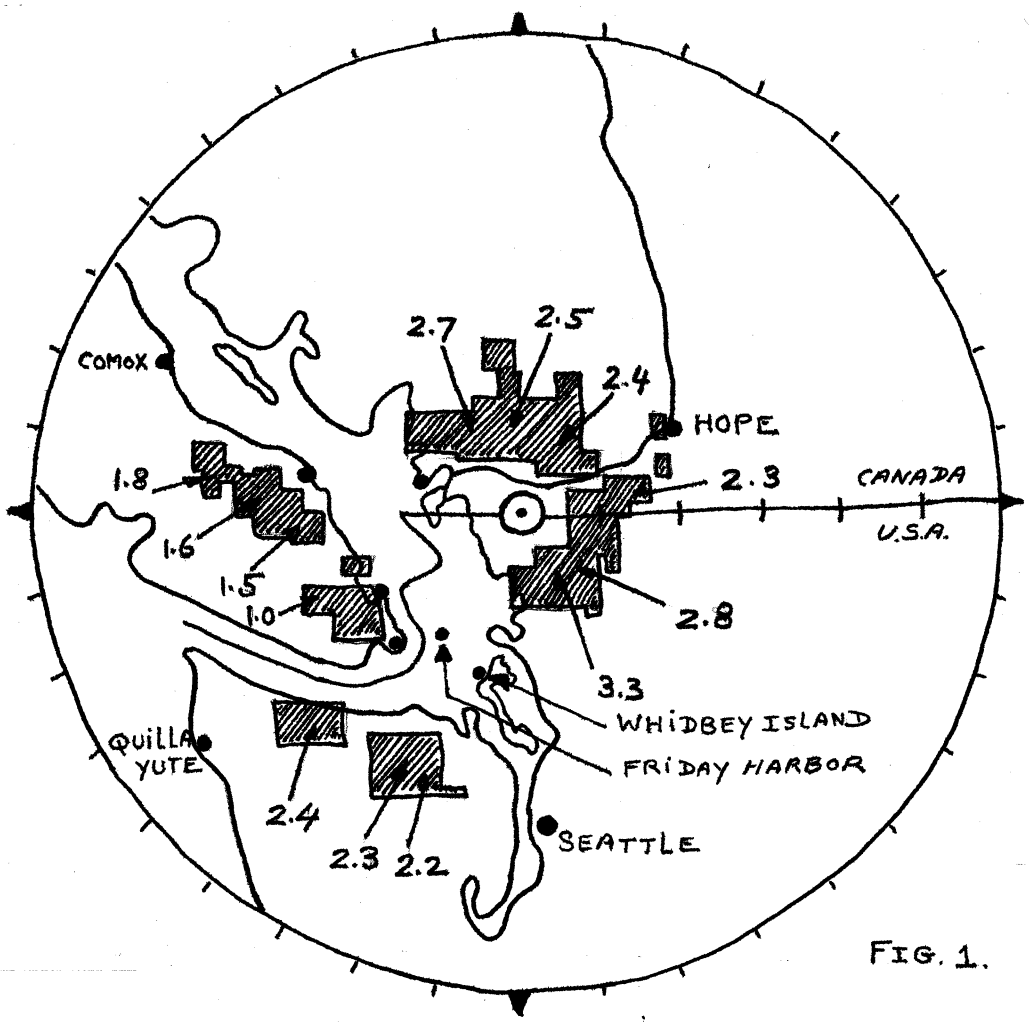

Fig. 1. The geographical area encompassed by the SCEPTRE radar system located at Abbotsford. The CAPPI (constant altitude plan position indicator) display has a radius of 240 km with the centre at Abbotsford. The hatched areas are produced automatically by the radar program when the scanning altitude is set for 1.5 km. At this elevation, the mountain ranges present a constant return echo and to avoid confusion those areas are "blocked-out". The arrows with the attached numbers give roughly the location and elevation (in km) of the more significant mountain peaks.

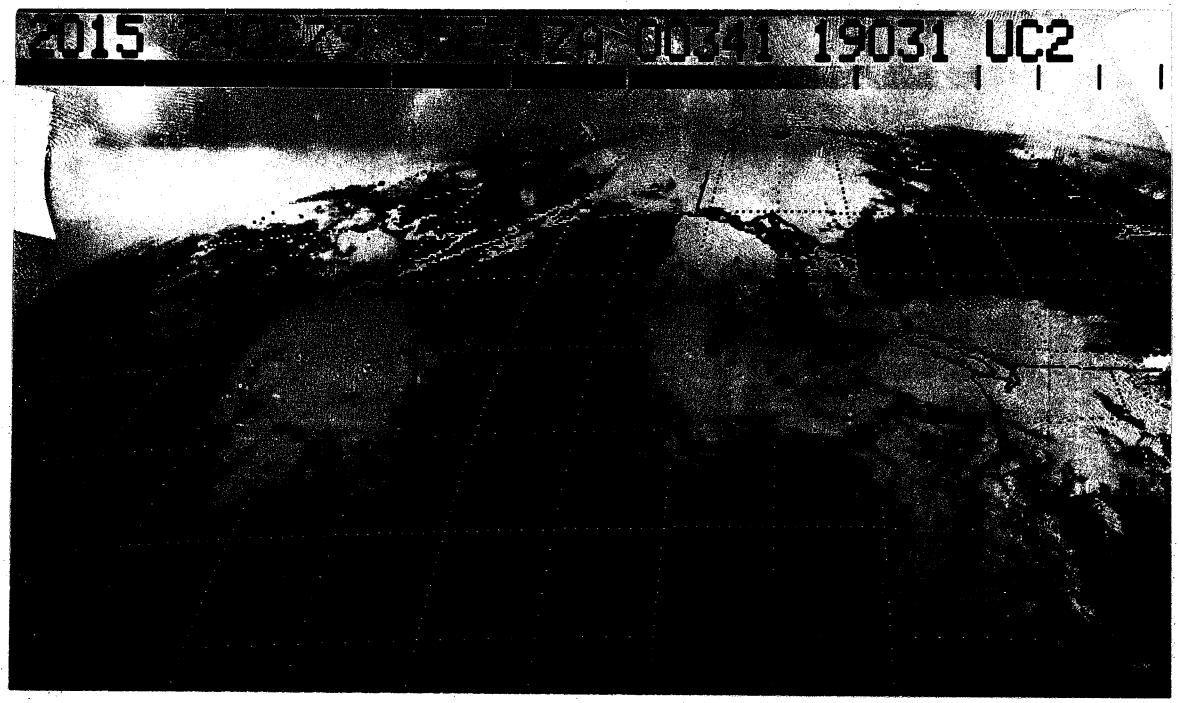

FIG. 2. SATELLITE PICTURE FOR OCT. 24, 1979 AT 2015 Z.

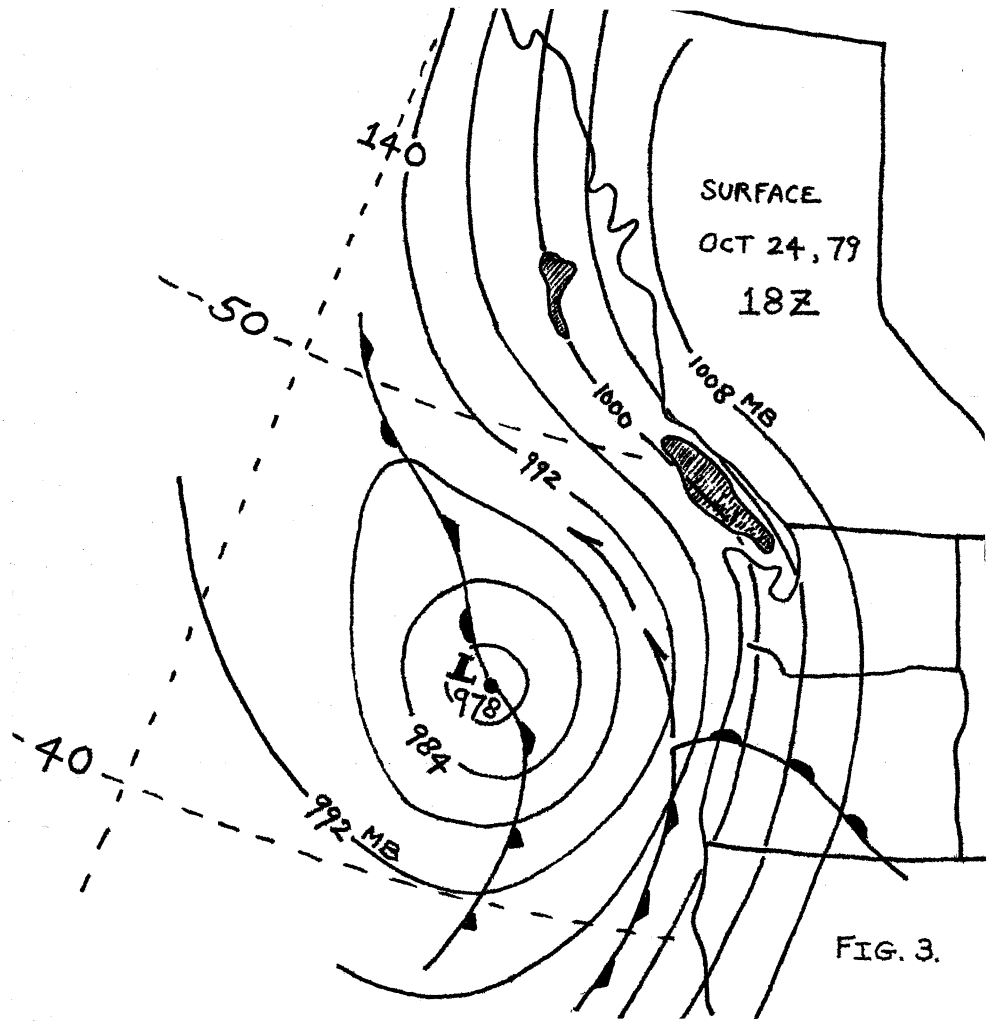

FIG. 3. ISOBARIC SURFACE CHART 18Z OCT. 24, 1979.

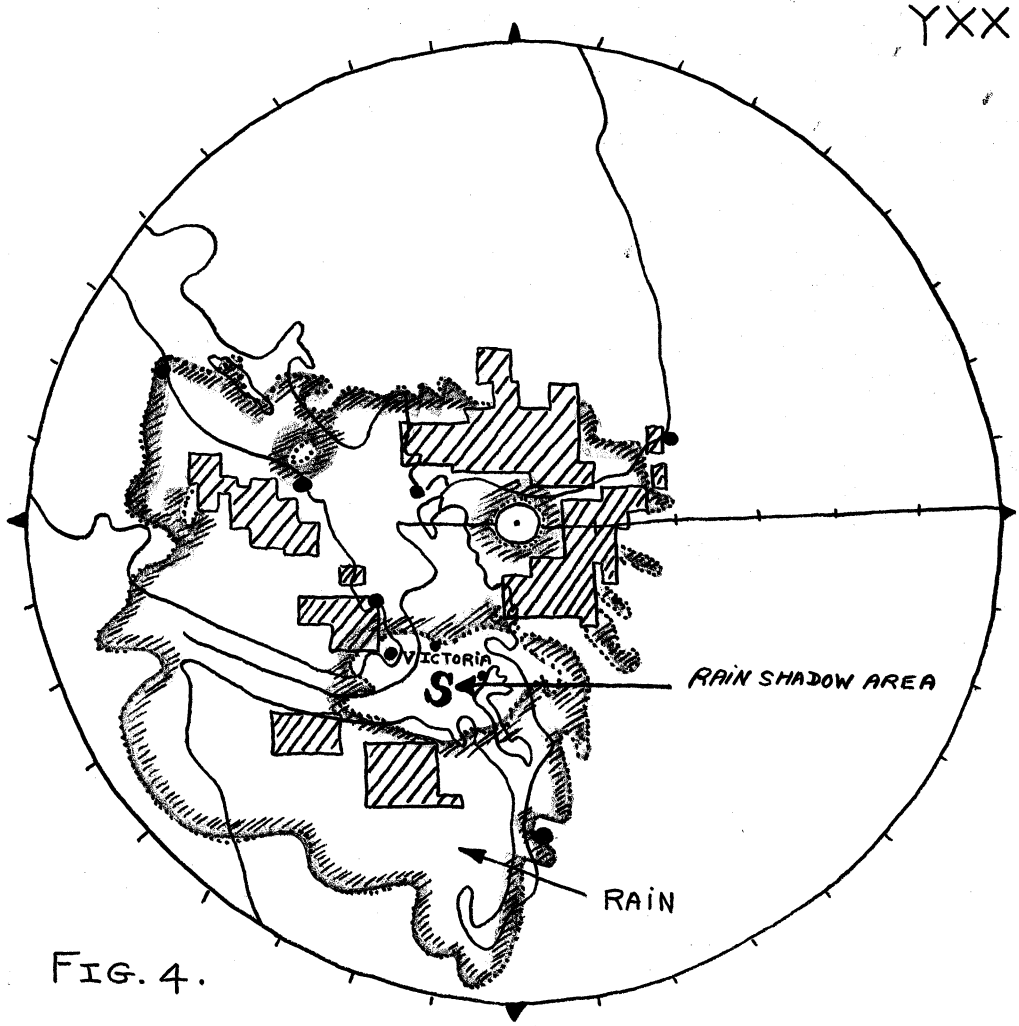

FIG. 4.

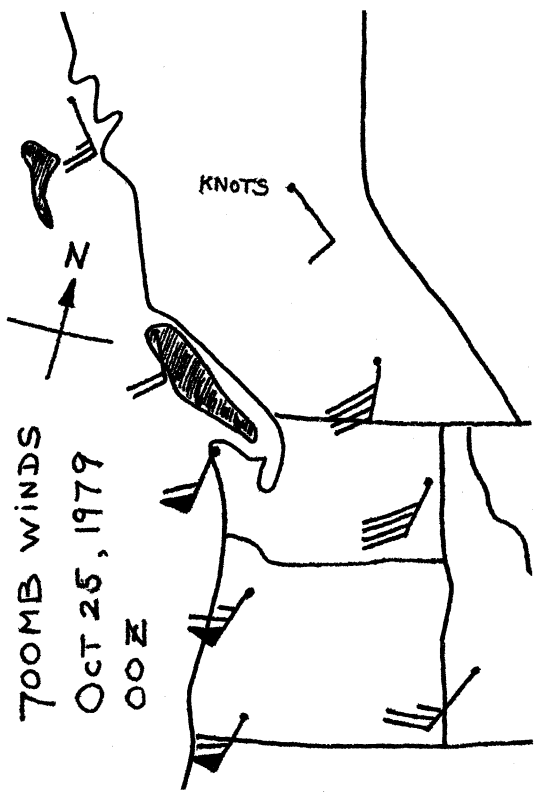

FIG. 5. THE 700MB WINDS.

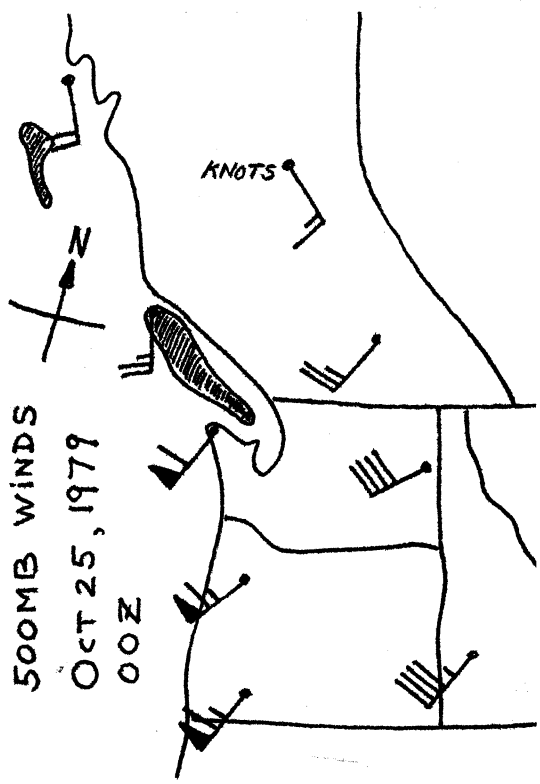

FIG. 6. THE 500MB WINDS.