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Mountain Forecast Verification - Snowfall Amounts 1982/83

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INTRODUCTION

Snowfall amount verification for Grouse, Whistler, and Allison Pass has been carried out for the past 8 winters. Similar data for Rogers Pass has been produced for the past 2 years (see References). At the close of the current winter season, it has been possible to expand the verification procedure to all the mountain forecast regions in B.C.

THE VERIFICATION POINTS

Although the snowfall amounts are produced as an areal forecast, practical considerations allow only point verifications. Variabilities induced by physical features such as terrain and the presence of significant water bodies preclude the possibility of locating representative sites for this purpose. In the ideal case, snowfall at every reporting site would be verified. Until this procedure can be automated, the sheer volume of numbers that must be transcribed by hand makes this procedure unmanageable.

The choice of verifying points was determined by using the following considerations:

1. at least one site must reside in each of the 9 mountain forecast regions,
2. a reasonably complete snowfall record must be available for the site,
3. previously chosen sites are retained to permit time-trend comparisons.

The following sites were chosen (see Figure 1 for locations):

South Coast Mountains	- Grouse Mountain	1120 metres
	- Whistler	1818
	- Allison Pass	1340
Vancouver Island Mountains	- Mt. Washington	1180
Skeena Mountains	- Salvus	30
	- Bear Pass	400
Thompson-Okanagan Mountains	- Apex Alpine	1666
	- Big White	1841
South Columbia Mountains	- Kootenay Pass	1780
North Columbia Mountains	- Rogers Pass	1330
Yoho Park	- Wapta Lake	1580
Cariboo Mountains	- Blue River	683
	- Red Pass	1040
Hart Mountains	- Pine Pass	950

THE PROCEDURE

Recorded 24-hour snowfall amounts at each of the 14 sites were compared to the quantities forecast for each of the appropriate mountain forecast regions. Due to time restraints, only the early morning forecast was considered. It should be noted that in cases where the freezing level is well above the station elevation, these amounts are misleading, since rain would be reported instead of snow. In previous years, the format of the forecasts made it fairly simple to allow for this effect. This year it has introduced certain errors. A check of the data at a few of the locations by separating the rain events, has indicated improvements in the order of 5-7 percentage points for the verification scores at coastal locations. Very little difference is apparent in the interior.

The amounts, forecast and observed, were separated into the same ranges as used in previous years. That is: 0, 0.1-10, 11-20, 21-50, and more than 50, all in centimetres. Each daily record during the core winter months (Dec.-Mar.) was entered into a contingency table. The completed tables are produced here as Figures 2(a-n).

All occurrences where the forecast and the observed category coincide are defined as "hits". Where the forecast amount falls into the adjacent observed value, a "near miss" is tabulated. Any further deviation between the forecast and the observed is handled as a "miss".

THE RESULTS

To the right of each contingency table (Figures 2(a-n)) is a summary block. This consists of the percentage of hits, near misses, and misses at each site. The percentage of hits varies from 28% at Salvus to 64% at Big White. Near misses range from 26% at Big White to 44% at Pine Pass. The poor forecasts (misses) account for between 9% (Apex) and 37% (Salvus).

One point becomes apparent when perusing the contingency tables - a significant bias to overforecasting is present. Correct occurrences lie along the diagonal from the upper left to the lower right. Events to the right represent overforecasts, and to the left, underforecasts. This effect is most apparent at Wapta Lake where only one occurrence of snowfall over 10 centimetres was recorded during the winter. The forecasts (for Yoho Park), on the other hand, called for more than 10 centimetres on 29 occasions during the same period. There is even one forecast for more than 50 cm per 24 hours.

One factor in this high bias is related to the verification procedure itself. Snowfall at a specific site is verified against the forecast for an area. If the freezing level over the area is significantly higher than the elevation of the site, then only rain could be observed at the site while snowfall occurs at nearby higher levels. Verification of precipitation, rather than snow, would in this case, improve the score. Unfortunately, precipitation data for most of the sites is not available until much later, making a relatively timely verification procedure impossible.

THE TRENDS

Another factor which might be of interest is a comparison of scores over the past years. This data is only available at a few sites. Figure 3 depicts the trends in the percentage of hits for Grouse and Whistler (1975/76 - 1982/83) and for Allison and Rogers Pass (1979/80 - 1982/83). The mean at each site is depicted by a horizontal line. High points are seen to have occurred at Grouse (80/81), Whistler (78/79, 79/80), Allison (80/81), and Rogers Pass (81/82). A downward trend is apparent in recent years.

COMPARISON WITH LAST YEAR

A tabulation of the percentage of hits, near misses, and misses is presented in Figure 4. In most cases there has been a reduction in the percentage of hits. At Big White no change has occurred. At Kootenay Pass there is an increase from 53% to 56%.

CONCLUSIONS

A consistent bias to forecasting high snowfall amount is evident at all the sites that were verified. It must be remembered that the sites are located at relatively low elevations compared to most of the forecast areas. The area forecasts should predict higher values of precipitation than expected at the valley locations where observations are available. The problem is in determining the degree of this excess, so as not to negate the value of the forecasts for users at the valley locations. An intimate knowledge of the climatology of the B.C. mountains is an invaluable aid in coming to this determination for a diversity of synoptic situations.

Another factor of some importance is related to the longwave pattern. That is, a persistant ridge or trough over the area will affect a particular winter's scores. One can find a strong correlation between the verification score and precipitation occurrence. Peaks in the trend graphs tend to be associated with drought years.

Several factors during the winter of 1982/83 would tend to induce lower snowfall verification scores. First of all, precipitation (especially along the coast) was above normal, and freezing levels in most areas were considerably higher than usual. Increased rain at the expense of snowfall will have a depressing effect on the verification statistics. Other reasons are related to changes of procedure at the PWC. This year's 4 AM issue time (as opposed to previous years 6 AM) is so early that it does not allow input from the current (12 GMT) radiosonde data. The splitting of snowfall into two 12 hour periods instead of one 24 hour amount would tend to inflate the resultant forecast. The staff that had the responsibility for issuing the mountain forecast guidance this year, did not have the same familiarity with B.C. mountain climatology as the forecasters of earlier years.

A comparison of the scores from year to year should be used with some caution. The factors listed above should be considered. A longer historical record of scores is required before a really meaningful assessment of continuing performance can be formulated.

REFERENCES

Gigliotti, T.	PRTN 79-015	Examination of the PWC Mountain Forecast Program QPF
Puss, V.	PRTN 80-020	Verification of the Forecast Snow Amounts Over the South Coast Mountains
Puss, V.	PRTN 81-015	Snowfall Forecast Verification 1980/81 Over Southwestern B.C.
Puss, V.	PRTN 82-007	The Southwestern Coast Snowfall Verification 1981/82
Puss, V.	PRTN 82-008	Rogers Pass Snowfall Verification

Figure 1

Location of the Verification Sites

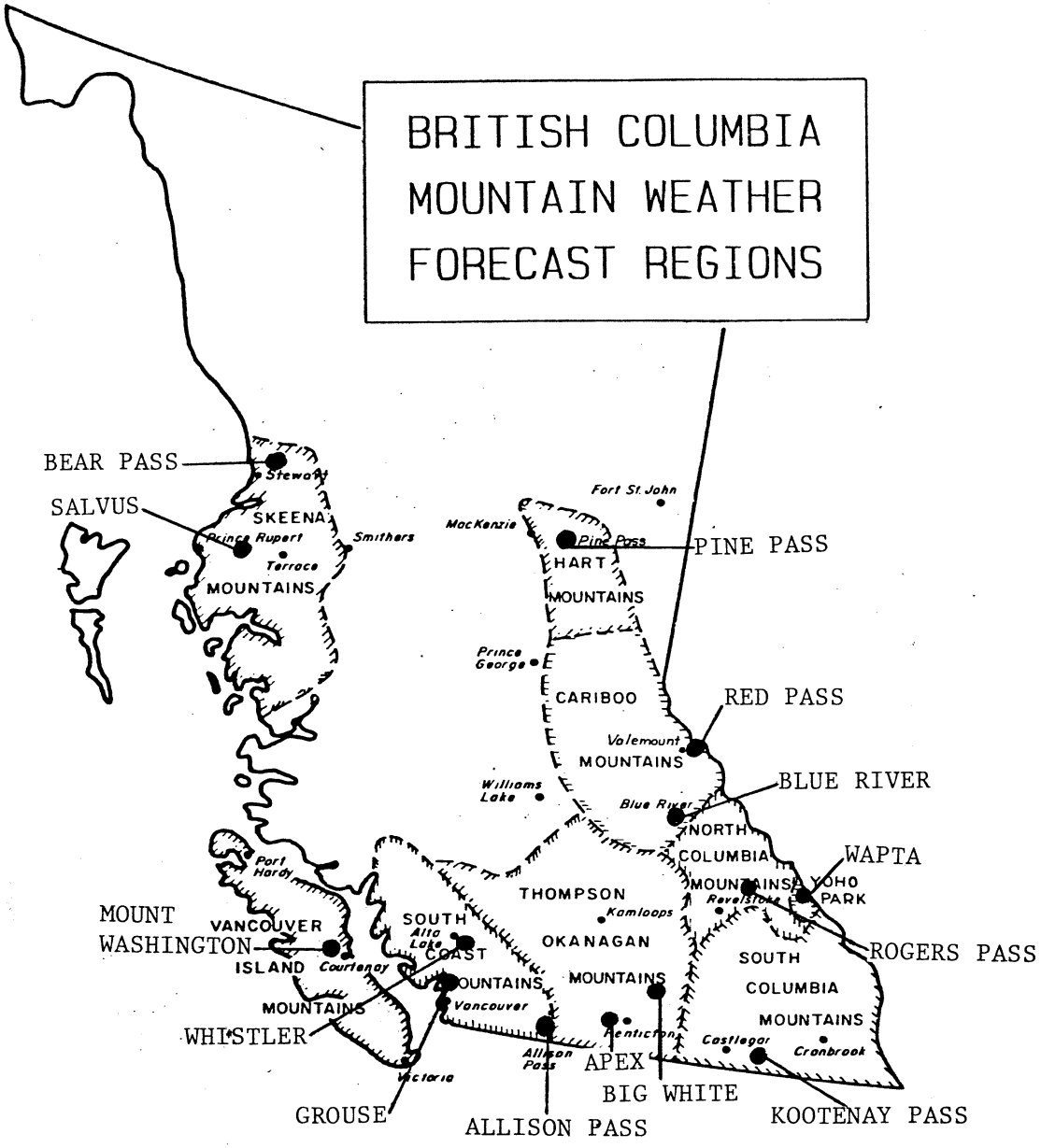


Figure 2(a-g)

Contingency Tables of Issued Forecast Snow Amounts Against Actual Amounts (1982-83)

(a) Grouse

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	19	8	5	7	1	40
.1-10	7	15	12	9	0	43
11-20	2	1	7	1	0	11
21-50	1	2	1	3	0	7
> 50	0	0	0	1	0	1
Total Fcsts	29	26	25	21	1	102

Hits 44 = 43%
Near Miss 31 = 31%
Miss 27 = 26%

(b) Whistler

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	22	9	3	0	0	34
.1-10	3	16	17	18	0	54
11-20	1	1	8	3	0	13
21-50	0	0	2	4	0	6
> 50	0	0	0	0	0	0
Total Fcsts	26	26	30	25	0	107

Hits 50 = 47%
Near Miss 35 = 33%
Miss 22 = 20%

(c) Allison

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	16	8	7	5	1	37
.1-10	6	14	12	12	0	44
11-20	0	1	0	1	0	2
21-50	0	1	0	1	0	2
> 50	0	0	0	0	0	0
Total Fcsts	22	24	19	19	1	85

Hits 31 = 36%
Near Miss 28 = 33%
Miss 26 = 31%

(d) Mt Washington

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	18	9	2	0	0	29
.1-10	3	10	6	5	1	25
11-20	0	1	4	4	2	11
21-50	0	1	0	4	0	5
>50	0	0	1	1	0	2
Total Fcsts	21	21	13	14	3	72

Hits 36 = 50%
Near Miss 24 = 33%
Miss 12 = 17%

(e) Apex

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	19	12	2	2	1	36
.1-10	5	30	13	2	0	50
11-20	0	2	3	0	0	5
21-50	0	1	1	0	0	2
> 50	0	0	0	0	0	0
Total Fcsts	24	45	19	4	1	93

Hits 52 = 56%
Near Miss 33 = 35%
Miss 8 = 9%

(f) Big White

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	21	6	3	1	0	31
.1-10	7	38	11	3	1	60
11-20	1	3	7	0	0	11
21-50	0	1	0	0	0	1
>50	0	0	0	0	0	0
Total Fcsts	29	48	21	4	1	103

Hits 66 = 64%
Near Miss 27 = 26%
Miss 10 = 10%

(g) Kootenay Pass

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	>50	Actual Totals
0	22	6	3	5	0	36
.1-10	3	25	15	7	0	50
11-20	0	2	9	3	0	14
21-50	0	1	0	2	0	3
>50	0	0	0	0	0	0
Total Fcsts	25	34	27	17	0	103

Hits 58 = 56%
Near Miss 29 = 28%
Miss 16 = 16%

Figure 2(h-n)

Contingency Tables of Issued Forecast Snow Amounts Against Actual Amounts (1982-83)

(h) Rogers Pass

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	19	3	1	0	0	23
.1-10	3	23	20	10	0	56
11-20	0	0	6	5	0	11
21-50	0	1	0	1	0	2
> 50	0	0	0	0	0	0
Total Fcsts	22	27	27	16	0	92

Hits 49 = 53%
Near Miss 31 = 34%
Miss 12 = 13%

(i) Wapta

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	16	9	6	4	0	35
.1-10	6	24	13	5	1	49
11-20	0	1	0	0	0	1
21-50	0	0	0	0	0	0
> 50	0	0	0	0	0	0
Total Fcsts	22	34	19	9	1	85

Hits 40 = 47%
Near Miss 29 = 34%
Miss 16 = 19%

(j) Blue River

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	18	11	3	1	0	33
.1-10	6	37	18	11	1	73
11-20	1	5	2	1	0	9
21-50	0	0	0	0	0	0
> 50	0	0	0	0	0	0
Total Fcsts	25	53	23	13	1	115

Hits 57 = 50%
Near Miss 41 = 36%
Miss 17 = 14%

(k) Red Pass

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	25	23	6	3	0	57
.1-10	2	27	18	6	1	54
11-20	0	0	0	0	0	0
21-50	0	0	0	0	0	0
>50	0	0	0	0	0	0
Total Fcsts	27	50	24	9	1	111

Hits 52 = 47%
Near Miss 43 = 39%
Miss 16 = 14%

(l) Pine Pass

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	23	22	9	0	0	54
.1-10	3	19	15	3	0	40
11-20	0	2	2	2	0	6
21-50	0	1	1	1	0	3
> 50	0	0	0	0	0	0
Total Fcsts	26	44	27	6	0	103

Hits 45 = 44%
Near Miss 45 = 44%
Miss 13 = 12%

(m) Salvus

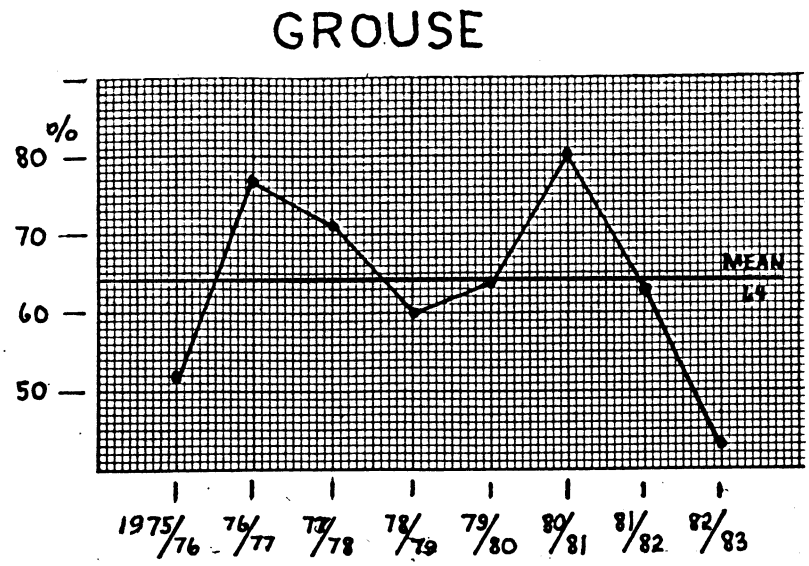
Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	23	27	18	15	1	84
.1-10	1	7	8	4	3	23
11-20	0	0	0	1	0	1
21-50	0	0	1	0	0	1
> 50	0	0	0	0	0	0
Total Fcsts	24	34	27	20	4	109

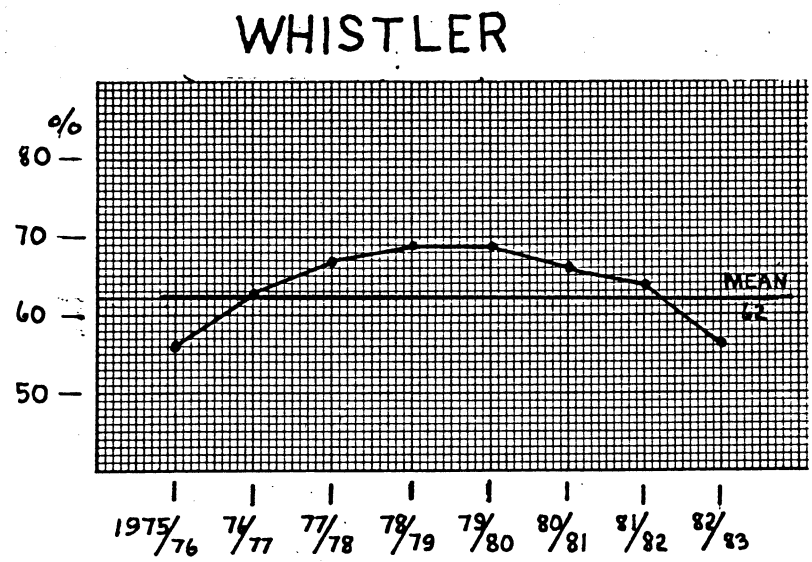
Hits 30 = 28%
Near Miss 38 = 35%
Miss 41 = 37%

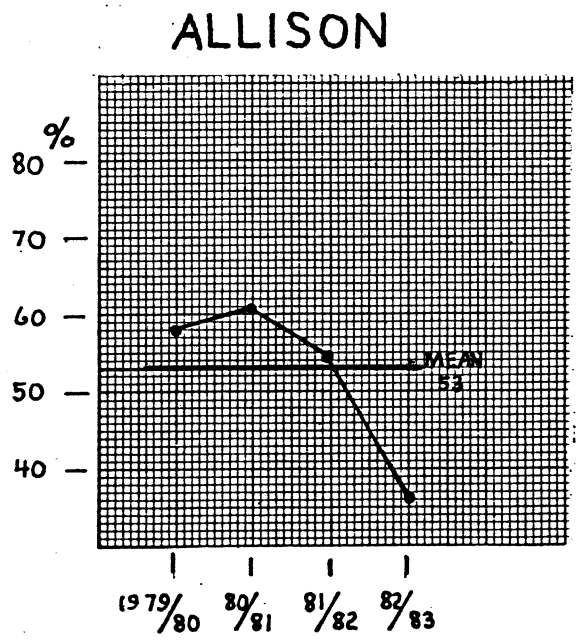
(n) Bear Pass

Actual (cm)	Forecast (cm) 0	.1-10	11-20	21-50	> 50	Actual Totals
0	22	12	9	7	1	51
.1-10	2	12	18	8	0	40
11-20	0	1	7	4	2	14
21-50	0	0	0	2	0	2
> 50	0	0	0	0	0	0
Total Fcsts	24	25	34	21	3	107

Hits 43 = 40%
Near Miss 37 = 35%
Miss 27 = 25%







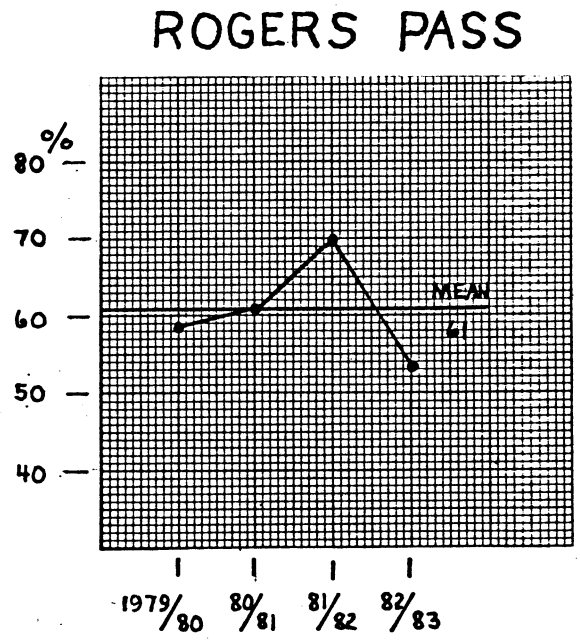


Figure 3. Trends of the percentage of hits over the past several years.

Figure 4

Summary of Snowfall Amount Forecasts

	Dec.81-Mar.82			Dec.82-Mar.83		
	Hit	Near Miss	Miss	Hit	Near Miss	Miss
	%	%	%	%	%	%
Grouse	62	31	7	43	31	26
Whistler	64	30	6	47	33	20
Allison Pass	56	39	5	36	33	31
Mt. Washington				50	33	17
Apex Alpine	77	23	0	56	35	9
Big White	64	32	4	64	26	10
Kootenay Pass	53	44	3	56	28	16
Rogers Pass	70	23	7	53	34	13
Wapta	59	39	2	47	34	19
Blue River	62	35	3	50	36	14
Red Pass				47	39	14
Pine Pass	48	45	7	44	44	12
Salvus	50	42	8	28	35	37
Bear Pass	52	42	6	40	35	25