NOTES AND CORRESPONDENCE

A Comparison of Canadian and United States Standard Methods of Measuring Precipitation

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ABSTRACT

Methods of measuring precipitation vary from country to country. Consequently, the comparability of precipitation data along international borders is questionable. The present paper compares 5 years of precipitation data at Windsor, Ontario, using the standard Canadian and United States methods of measuring precipitation. Monthly rain amounts are very similar, but substantial differences exist in snow measurement. The Canadian method appears to overestimate precipitation from snowfall.

1. Introduction

One of the most important of all climatic parameters published by any national weather service is precipitation: the amount of water in any form that reaches the earth from the atmosphere. However, every national weather service has its own method of measuring precipitation. There is great variation in the areas of the collecting surfaces of standard rain gages and the height at which they are exposed. Snow is caught in a gage and melted, or the depth of new fallen snow is measured and a constant water content assumed. Maps of continental and world precipitation are drawn, assuming that the precipitation data obtained by these various methods are comparable. It is important to know if this is indeed the case in Canada and the United States where two different methods of measurement are followed since isohyets must be drawn across the international boundaries.

Many studies have been made comparing the accuracies of different types of precipitation gages (Bruce and Potter, 1957; Bleasdale, 1959). It is generally accepted that none of the raingages accurately measures the amount of water that reaches the earth's surface. It is also generally believed that the Canadian method of estimating precipitation in the form of snow is inaccurate (Hare and Hay, 1971; Jackson 1960). It is not the purpose of the research reported here to compare the accuracy of the two methods of measuring

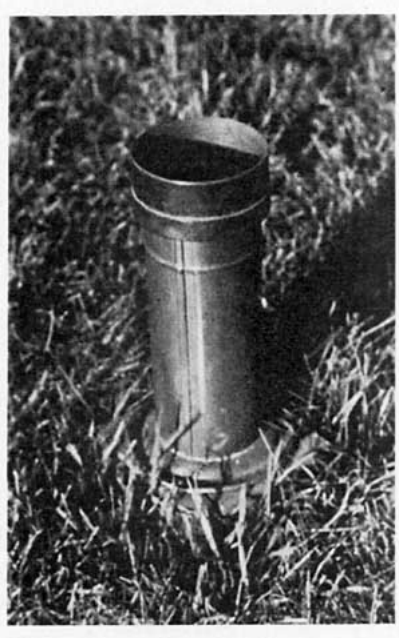

FIG. 1. The Canadian standard 10 inch² raingage.

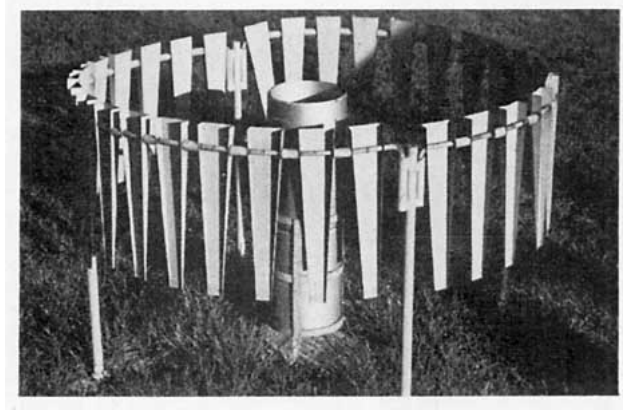

FIG. 2. The United States standard 8 inch diameter raingage.

TABLE 1. Monthly and seasonal precipitation totals (inches) for Windsor 1969–74.

Year	Month	Canadian method	United States method
1969	April	3.78	3.79
	June	4.48	4.38
	July	8.01	8.21
	August	2.80	2.85
	September	0.81	0.78
	October	1.65	1.56
	November	2.59	2.55
Warm season total		17.75	17.78
Snow season total		6.37	6.34
7-month total		24.12	24.12
1970	February	1.16	1.06
	March	2.57	2.31
	April	4.15	3.74
	May	2.67	2.63
	June	2.98	3.01
	July	4.66	4.60
	August	1.07	1.09
	September	2.36	2.34
	October	1.95	1.85
	November	2.62	2.56
Warm season total		15.69	15.52
Snow season total		10.50	9.67
10-month total		26.19	25.19
1971	January	0.57	0.51
	February	2.67	2.78
	March	1.85	1.59
	April	1.06	1.02
	May	1.76	1.71
	June	2.22	2.11
	July	1.52	1.49
	August	3.32	3.29
	September	2.48	2.46
	October	1.16	1.04
	November	1.64	1.57
	December	4.05	3.90
Warm season total		12.46	12.10
Snow season total		11.84	11.27
Annual total		24.30	23.37
1972	January	1.33	1.16
	February	0.74	0.71
	March	2.64	2.64
	April	4.05	4.02
	May	1.74	1.67
	June	2.40	2.38
	July	1.21	1.15
	September	3.60	3.59
	October	2.85	2.85
	November	3.21	3.19
	December	2.65	2.67
Warm season total		11.80	11.64
Snow season total		14.62	14.39
11-month total		26.42	26.03
1973	January	1.53	1.59
	February	1.02	0.81
	March	4.37	4.35
	April	1.38	1.36
	May	2.66	2.60
	June	6.06	6.14
	July	4.77	4.69
	August	2.58	2.52
	September	1.93	1.85
	October	2.66	2.52
	November	4.20	4.13
	December	3.62	3.44
Warm season total		20.66	20.32
Snow season total		16.12	15.68
Annual total		36.78	36.00
1974	January	4.07	3.83
	February	1.97	1.87
	March	3.99	3.46
	April	3.94	3.72
	May	3.34	3.33
	June	2.05	2.02
	July	.90	.93
	August	1.74	1.72
	September	1.94	1.93
	October	.70	.71
Warm season total		10.67	10.64
Snow season total		13.97	12.88
10-month total		24.64	23.52
1969–1974			
Warm season totals		89.03	88.00
Snow season totals		73.42	70.23
Total		162.45	158.23

precipitation. Only the differences in the precipitation estimates, and thus the comparability of Canadian and United States precipitation data, are investigated.

The Canadian standard raingage (Fig. 1) has a 10 inch^2 surface exposed 1 ft above the ground. Newly fallen snow is measured with a ruler and the water equivelent estimated by dividing by 10. All but some 300 of Canada's 2400 reporting climatic stations estimate precipitation from snow in this way. The United States standard rain- and snowgage (Fig. 2) has a surface 8 inches in diameter mounted 31 inches above the ground. A shield to reduce the effect of wind

in reducing gage catch is used with approximately 6000 of the gages at the first class stations. The snow that is caught in the gage is melted to determine water equivalent.

The standard Canadian raingage and United States rain-snowgage with Alter shield were installed at the University of Windsor weather station in 1969. The instruments are well exposed about 20 ft apart. Readings are taken morning and evening according to standard meteorological practices. At least 10 observers have been responsible for the observations during the 5 years of record. It is improbable that any observational bias exists in the data. It is believed that the 5 years' data are the result of normal observational procedures, although it is realized that the analysis has the limitations of research at a single station.

2. Data analysis

Monthly precipitation totals are shown in Table 1. Since snow occurred each month from November to April in all 5 years, the totals for this 6-month snow season are shown separately from the warm (rain) season, May to October. Total precipitation as measured by the United States gage was 97.4% of the Canadian estimate.

Considering the warm season only, the United States gage caught 98.8% as much rain as the Canadian gage. This is exactly the difference found in the study of the two gages by Denison (1941), although in the latter case the Canadian gage was mounted at the same height as the United States gage.

For the 6-month snow season, the United States gage measurement was 95.7% of the Canadian precipitation estimate. However, if precipitation received during snow days only is considered (Table 2), there was a 12.5% difference in the precipitation totals. That is, the snow that is caught in the United States gage and melted averaged 87.5% of the precipitation estimated by converting depth of snow to water equivalent using the 10:1 ratio.

3. Conclusion

Considering the slightly more than 5 years of data, it can be concluded that as far as rainfall is concerned, there is little difference (1.2%) in the catch of the two gages. If, as is generally believed, the higher catch is the more accurate, it can be assumed that the United States gage with the Alter shield is 98.8% as efficient an estimator of rainfall as the Canadian gage.

If the United States gage with the Alter shield is similarly 98.8% accurate with respect to snow catch, then the Canadian method of estimating precipitation from snowfall represents an overestimate of about 11% in the Windsor area. The overestimate could be due to observer error in estimating depth of snowfall, or a ratio of greater than 10:1 in converting snow depth to water equivalent. Since the average density for snow in the Windsor area is estimated as 0.09 (Potter, 1965), it is probable that the overestimation is due to the difficulty the observer has in obtaining representative measurements of snow depth.

TABLE 2. Precipitation totals for snow days only (inches).

Year	Month	Canadian	United States
1969	November	0.20	0.20
1970	February	1.16	1.06
	March	0.27	0.10
1971	January	0.57	0.51
	February	0.45	0.42
	March	0.20	0.16
	November	0.05	0.05
	December	0.14	0.10
1972	January	0.66	0.58
	February	0.41	0.40
	March	0.41	0.46
	November	0.25	0.22
	December	0.76	0.71
1973	February	0.85	0.65
	December	0.85	0.83
1974	January	1.30	1.05
	February	0.78	0.68
	March	0.30	0.23
Total		9.61	8.41

Windsor in the average year receives 42 inches of snowfall (water equivalent 4.2 inches). If this represents an overestimation of 11%, the proper water equivalent should be 3.7 inches. In other areas of Canada with larger snowfalls, and lower moisture equivalents, the overestimation of annual precipitation could be as much as 2–3 inches. It would appear that the more snowfall an area receives, the larger would be the discrepancy between the Canadian and United States estimates of precipitation. Consequently, in using the standard climatic summaries to draw isohyets across the international boundary, the probable overestimation of precipitation from snowfall in the Canadian data should be borne in mind.

REFERENCES

Bleasdale, A., 1959: Measurement of rainfall. *Weather*, **14**, 12–18.

Bruce, J. P., and J. G. Potter, 1957: The accuracy of precipitation measurements. Roy. Meteor. Soc. Can., *Proc. Third Nat. Meeting*.

Denison, F. W., 1941: A report on the difference between precipitation records as taken on standard Canadian and United States rain gauges. *Bull. Amer. Meteor. Soc.*, **22**, No. 2, 65–67.

Hare, F. K., and J. E. Hay, 1971: Anomalies in the large-scale annual water balance over North America. *Can. Geogr.*, **15**, 79–94.

Jackson, C. I., 1960: Snowfall measurements in northern Canada. *Quart. J. Roy. Meteor. Soc.*, **86**, 273–275.

Potter, J. G., 1965: Water content of freshly fallen snow. Tech. Circ. 569, Canada, Dept. of Transport, Meteor. Branch, Toronto.