CLIMATOLOGY

NORMALITY AND VARIABILITY OF SEASONAL SNOWFALL IN THE EASTERN TWO-THIRDS OF THE UNITED STATES

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ABSTRACT

The "normal" range of seasonal snowfall values in the eastern two-thirds of the United States has been determined by calculating the upper and lower quartiles based on seasonal snowfall values drawn from 68 sites (2). Seasonal snowfall amounts above the upper quartile value would constitute above-normal amounts while seasonal amounts below the lower quartile would represent below-normal amounts. The upper and lower quartile values have been mapped so that the values for a given location may be estimated and the spatial distribution of these data revealed. An interseasonal variability index was also calcualted to reveal those locations with extreme and minimal interseasonal variability of snowfall amounts.

1. INTRODUCTION

The normality and fluctuations of temperature, precipitation, and other meteorological variables have always been of interest to climatologists. While the 30-year mean has been accepted as representative of "average" conditions, recent studies have focused on the applicability of both means/standard deviations as well as medians/quartiles to delimit the "normal" range of climatic variables (3, 4, 5). Statistical approaches to determine the degree of climatic variability have also been detailed (6) but these usually are best applied to normally distributed data. This study attempts to delimit "normal" seasonal snowfall and seasonal snowfall variability in the eastern two-thirds of the United States by the median/quartile approach, the preferred approach for non-normally distributed data.

2. METHODOLOGY

As seasonal snowfall in the southern half of the United States is so highly variable from year to year, the median best represents the average snowfall value, and the quartiles best represent the normal range in this region. In the north central United States as well as in interior New England, snowfall is less variable and a long-term sample would reveal a more normal distribution on an interseasonal basis. Here, the mean and standard deviation approach would be applicable. However, to determine the normal range of seasonal snowfall for the entire eastern United States, a uniform statistical application is required. The mean/standard deviation approach is not used in this study because it would lead to invalid results, especially south of the Ohio and Missouri Rivers. The approach utilized in this study will tend to be conservative in estimating the normal range of seasonal snowfall in locations where snowfall is more normally distributed. This would be especially true near the snowbelts of the Great Lakes.

The median annual snowfall and associated quartiles at 68 sites for the 1939–40 to 1983–84 period have been calculated so that the normal range of snowfall and degree of variability may be determined. This information has been plotted so as to visualize the spatial patterns.

3. RESULTS

The spatial distribution of median snowfall, as well as for both upper and lower quartiles, exhibits a latitudinal tendency only interrupted by the Appalachians and the Great Lakes (Figs. 1A–1C). Maritime influences of the Atlantic Ocean cause the slight northward deformation of the median values. Figures 1B and 1C can be used to determine the range of normal seasonal snowfall. Table 1 displays some sample values.

The Great Lakes cause a wide range of values to be found over a relatively short distance. Duluth, Minnesota, for example, has a median value of 72.2 in. per year with over 95 in. required for an above-normal season. Marquette, Michigan, downwind from Lake Superior, needs almost 133 in. for an abnormally snowy season. To the south, Birmingham needs only a trace of snow in a season to fall into the normal range and only 3 in. of snow is required for an above normal

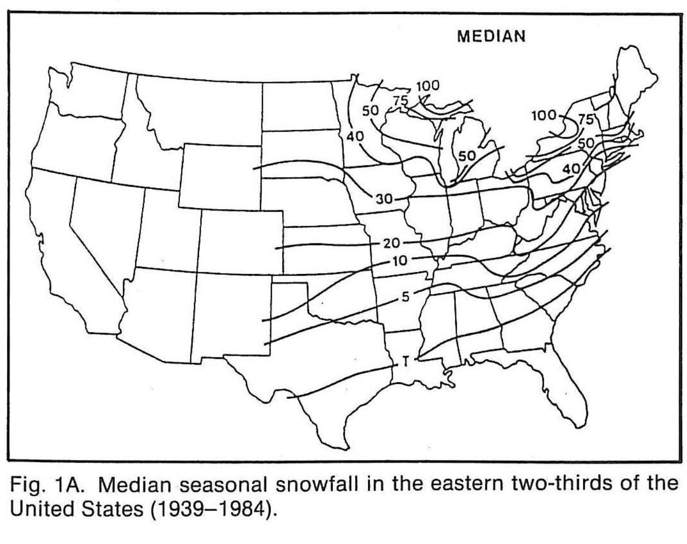

Fig. 1A. Median seasonal snowfall in the eastern two-thirds of the United States (1939–1984).

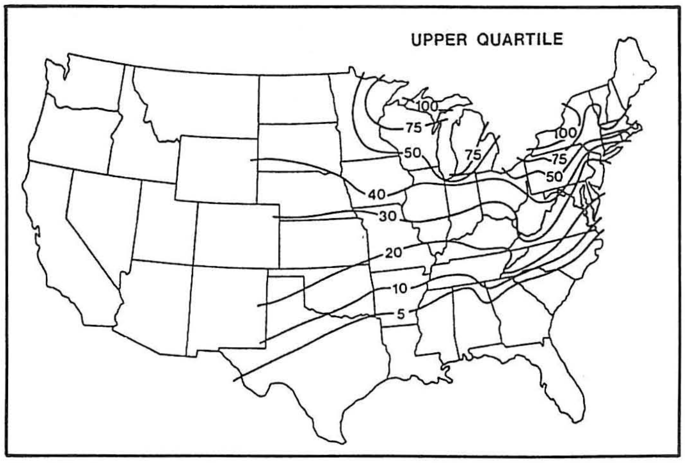

Fig. 1B. Upper quartile value (above which snowfall would be deemed "above normal") for seasonal snowfall in the eastern two-thirds of the United States.

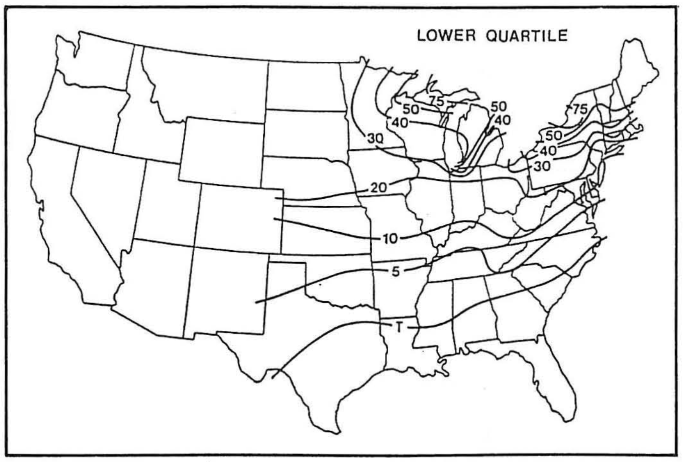

Fig. 1C. Lower quartile value (below which snowfall would be deemed "below normal") for seasonal snowfall in the eastern two-thirds of the United States.

Table 1. Examples of median and normal seasonal snowfall values in inches.

City	Median	Upper Quartile	Lower Quartile
Birmingham	.8	2.2	T
Boston	44.1	52.0	29.8
Buffalo	88.7	109.9	71.5
Chicago	37.9	52.2	29.4
Cincinnati	21.3	27.2	14.0
Detroit	35.4	45.0	26.6
Duluth	72.2	95.7	50.0
Little Rock	4.5	7.0	2.3
Marquette	108.7	132.8	89.6
Memphis	4.0	7.5	1.4
Oklahoma City	8.1	12.2	4.0
Rapid City	33.7	47.2	25.9
St. Louis	21.1	25.2	10.6

season. The most extreme case studied was San Antonio, Texas, where totals less than a trace are below normal and values over a trace are above normal.

Interseasonal variability of snowfall can be determined using the following formula:

variability index = IQR/median
IQR (interquartile range) = upper quartile—lower quartile

The greatest variability of seasonal snowfall in the eastern United States is found along the southern tier of states (Fig. 1-D). The variability index value for Little Rock, Arkansas, for example, was 1.04 (7.0 − 2.3 / 4.5) while the variability index value at Buffalo was only .43 (109.9 − 71.5 / 88.7). The high index values in the south occur because in order for snow to fall in this region, much colder than normal winters are required. In the north, even warmer than normal winters will result in snowfall. Therefore, only a few winters will be cold enough (with storm tracks displaced far enough south) to trigger snow storms in the south while northern winters will always feature some degree of snowfall.

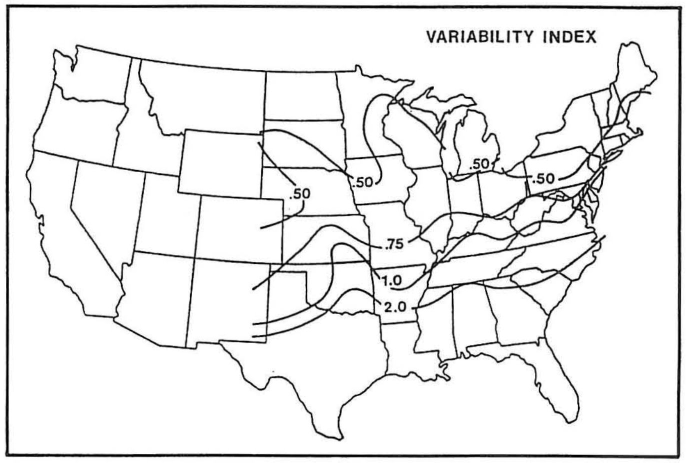

Fig. 1D. Interseasonal variability of snowfall in the eastern two-thirds of the United States.

The Great Lakes also enhance the statistical stability of seasonal snowfall in the north. Areas upwind from the Great Lakes have a greater degree of interseasonal variability than do locations downwind from the lakes. Note the northward displacement of the .50 index values west of the lakes and the southward shift east of the lakes. Duluth (.63), Chicago (.60) and Milwaukee (.58) (upwind from the lakes) stand in stark contrast with Marquette (.40), South Bend (.47), Buffalo (.43) and Rochester (.41). The Great Lakes always act as a moisture source for those regions downwind in the winter while locations upwind are more reliant upon the circulation patterns which change from one season to another.

4. CONCLUSION

The median/quartile approach can be used to determine the values that must be attained to consider seasonal snowfall to be above or below normal. Other than latitude, the Great Lakes and the Appalachians have a significant impact on the distribution of these values in the eastern United States. The Great Lakes also influence the interseasonal variation in snowfall totals as the downwind areas can always count on the lakes as a source of moisture during the winter months while upwind locations are more reliant on the more variable circulation patterns. Interseasonal snowfall variability is greatest in the south where most seasons have little snow but occasionally circulation patterns allow for significant amounts to fall there. These findings will be of greatest interest to climatologists and broadcast meteorologists who want to isolate abnormal snow seasons in the eastern United States.

NOTES AND REFERENCES

1. *Gregory E. Faiers received his Ph.D. in geography from Louisiana State University. He is currently professor of geography at Bowling Green State University. His research interests lie in water budget climatology, synoptic climatology, and natural environmental hazards.*

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