CLIMATOLOGY NOTE

DEFINING NORMAL PRECIPITATION

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ABSTRACT

The use of standard deviations to differentiate "normal" temperatures from "abnormal" temperatures is a valid procedure because temperature data tend to take on a normal distribution. Precipitation data distributions, on the contrary, often are skewed. The application of standard deviations to such data can result in unattainable values. This paper proposes that quartiles be utilized for the determination of "normal" values of precipitation. Snowfall data from Tennessee (2) are used as examples.

1. INTRODUCTION

In a recent article, Pielke and Waage (3) suggested that the determination of "*abnormal*" weather be based not on whether conditions were above or below some mean value but on whether conditions varied two or more standard deviations from the mean value. In regard to temperature data, this is indeed a valid basis and one which, hopefully, will be adopted on a substantial scale.

This paper, however, discusses the problem of applying this technique to precipitation data, and in particular, snowfall. A more appropriate statistical procedure for determining "*normal*" precipitation ranges is suggested.

2. METHODOLOGY

The distribution of precipitation data is often skewed. Hourly precipitation events at most locations are most commonly less than 0.1″ while also ranging up to two or three inches in an hour. In areas where mean snowfall is low but amounts are variable from year to year, standard deviations based on the mean may result in determining that negative amounts of snow may be required before a value is one standard deviation less than the mean.

When a distribution is skewed and there is a need to determine "*normal*" ranges of variability, a more resistant statistic is needed than the arithmetic mean. The arithmetic mean, upon which the standard deviations are based, tends to react to extreme cases so that while the majority of hourly rainfall events, for example, may be less than 0.10″, a few excessive events cause the mean to increase. Burn and Fox (4) suggest that the median is a better indicator of "*average*" precipitation than the arithmetic mean because the median is resistant to a few exceptional events in the distribution. A range of normal precipitation values based upon the median and quartiles is more appropriate for skewed data. The lower quartile (below which 25% of the distribution lies) can be used to determine below-normal values, while the upper quartile (above which 75% of the values lie) can be used to determine above-normal values.

3. RESULTS

Seasonal snowfall totals for five locations in Tennessee were compiled for the 1944–1982 period. Table 1 illustrates the problems of applying standard deviations to skewed data as well as the advantages of using quartiles. If the assumption is that snowfall has to be less than two standard deviations

Table 1. Normal seasonal snowfall ranges (in inches) as determined by standard deviations and quartiles for five locations in Tennessee. Data are for 1944–1962.

	Tri-cities	Chattanooga	Knoxville	Memphis	Nashville
Mean	17.51	4.13	12.61	5.57	11.62
S.D.	11.36	4.84	10.76	5.84	9.87
+2 S.D.	40.23	13.81	34.13	17.25	31.36
−2 S.D.	−5.21	−5.55	−8.91	−6.11	−8.12
Median	16.7	2.5	10.9	4.0	8.0
Lower Quartile	9.1	.1	5.4	1.2	3.4
Upper Quartile	23.7	7.0	17.6	7.9	19.8
Absolute Minimum	0.0	0.0	0.0	0.0	0.0
Absolute Maximum	51.0	21.8	56.7	23.8	38.5

below the mean for snowfall to be below normal, all five locations would have to have snowfall values substantially below zero for this to occur. Tri-Cities, for example, had a mean of 17.51" of snow per season with a standard deviation of 11.36". The *"normal"* range of snowfall would then be from −5.21" to 40.23". Values exceeding this range would be *"abnormal."* Since snowfall totals less than zero are impossible, abnormally low seasonal totals would never be realized.

When applying the median/quartile approach, Tri-Cities had a median value of 16.7" and a *"normal"* range from 9.1" (lower quartile) to 23.7" (upper quartile). A season would have above-normal snowfall at Tri-Cities if more than 23.7" fell, while a below-normal season would have less than 9.1". Chattanooga, on the other hand, had a median value of 2.5" with a *"normal"* range from 0.1" to 7". Since seasons with no measurable snowfall are relatively common there, only seasonal totals less than 0.1" would be abnormally low. By applying this approach it is impossible for negative values to result for the determination of below normal snowfall.

4. DISCUSSION

While using standard deviations for the determination of abnormal temperatures is usually valid, it is important to understand the distribution of the data before applying such a statistical procedure. Some precipitation distributions may be normal, but most are skewed and the median/quartile approach yields more valid results. If a distribution takes on the typical *"bell shape,"* it can be considered normal and appropriate for the standard deviation procedure. Let us hope that these procedures are adopted and applied properly so that the terms *"above"* and *"below"* normal accurately reflect significant deviations from the average conditions.

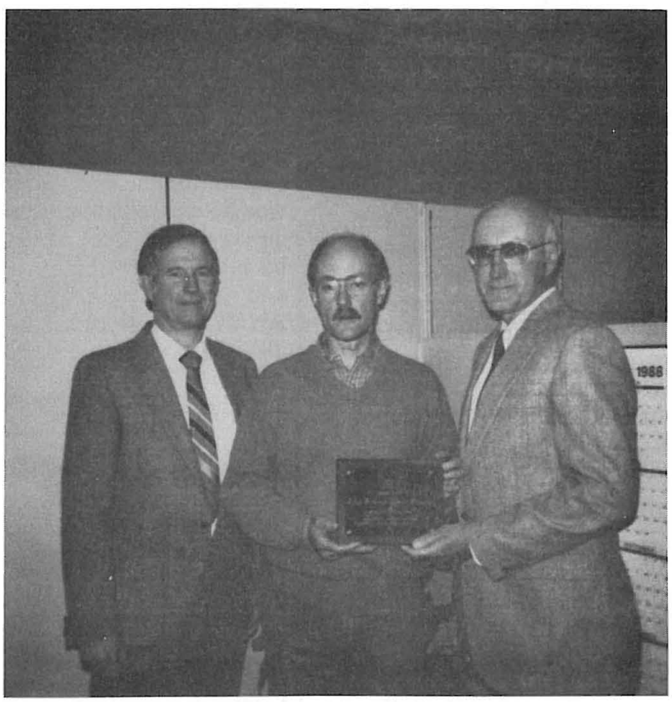
NOTES AND REFERENCES

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

2. National Climatic Data Center, 1983: *Local Climatological Data, Asheville, NC.*

3. Pielke, R. A., and N. Waage 1987: "Note on a Definition of Normal Weather," Nat Wea Dig, *Vol. 12, No. 3, 20–22.*

4. Burn, C. R., and M. F. Fox, 1986: "Introducing Statistics to Geography Students: The Case for Exploratory Data Analysis," Journal of Geography, *Vol. 85, No. 1, 28–31.*



AWARD PRESENTATION

Mr. Larry Peabody, FIC, WSFO, San Antonio, TX (right) presents a NWA Award to Mr. David Baxter, Editor, Texas Parks & Wildlife Magazine as Mr. Bill Hare, WPM, WSFO, San Antonio, TX looks on. The presentation was made in Austin, TX, on January 7, 1988.