Western Region Technical Attachment
No. 90-11
March 27, 1990

SOME THOUGHTS ON DROUGHT, PRECIPITATION CLIMATOLOGY, AND METHODOLOGY

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Much interest has been generated lately about drought in the western United States and, consequently, about "normal" precipitation. But what exactly is meant by normal? Is it simply the 1951-1980 arithmetic average computed by Asheville? And if a figure differs from normal, then is it to be considered "abnormal"? Several recent articles in *National Weather Digest* suggest some alternative means of defining normal precipitation.

As noted by Pielke and Waage, what usually is referred to as "normal" is in actuality an average (or arithmetic mean) value for the precipitation distribution in question. They suggest defining normal as a range, using a multiple of the standard deviation. This method would allow us to say that normal is plus/minus one (or two) standard deviations from the mean.

However, according to Panofsky and Brier, defining normal precipitation in this manner is complicated because the distribution is positively skewed. [Skew being positive if the mean is greater than the mode.] This skewing is due to the fact that a precipitation value of less than zero is not possible. This caused Faiers to look at the median of the distribution as a measure of normalcy. He defined normal as the range between the 1st and 3rd quartiles of the distribution. [The 1st quartile is the value between the 1st and 2nd quarters of the data points; and the 3rd quartile is that value between the 3rd and 4th quarters].

Using the monthly precipitation for San Francisco Downtown (1849-1989), a simple methodology for looking at the above approaches was developed. The data set was entered into a spreadsheet, arraying the monthly precipitation amounts by rainfall season (July to June). Most spreadsheet programs now make it a relatively simple exercise to calculate seasonal totals, means, standard deviations, mode, and median for the data set.

Monthly amounts were summed to determine both seasonal and annual precipitation as plotted in Fig. 1. Maximum and minimum values plus the standard deviation for each month were also calculated. From the seasonal totals, a running 30-year average seasonal rainfall was produced, as was a running 30-year standard deviation as shown on Fig. 2. Finally, the seasonal rainfall was sorted, allowing the determination of the median, and the 1st and 3rd quartiles. The resultant data are summarized.

SAN FRANCISCO DOWNTOWN PRECIPITATION

30-Year (1960-1989)	Mean:	20.71
	Standard Deviation:	7.55
	Median:	18.74
	1st Quartile:	15.47
	3rd Quartile:	25.09
	Mode:	23.06

By using the methods discussed, we can now define "normal" in a number of different ways. Using the mean, median, and mode, we derive single point values of 20.71, 18.74, and 23.06 inches respectively; while using plus or minus one standard deviation yields a range of 13.16 to 28.26, and between the 1st and 3rd quartile around the median ranges from 15.47 to 25.09 inches. Which method is correct? None of them should be considered as absolutely correct or incorrect, but these methods should demonstrate that there is more to life than the 30-year mean from Asheville. In addition to using some measure of normal to define drought, factors such as population growth and the impact of water shortage on individual activities need to be considered.

With questions of drought come those of climate change. By looking at the running 30-year standard deviation, it is possible to track the variability of rainfall. While it doesn't answer the question of why (or why not) the climate is changing, it at least gives us the ability to determine if the precipitation is becoming more (or less) variable.

More importantly, a consistent approach to expressing "ranges of normal" seems advisable; either on a regional or national level. While each of the methods has its positive aspects, using a range of one standard deviation either side of the mean would probably be the easiest to understand and to implement. (Most spreadsheets have built-in functions for standard deviation calculations). It would also be the most useful method for looking at long-term trends such as variations of 30-year standard deviations.

Whichever method might be adopted, it would provide users such as water agencies, engineering firms, and the media, more statistically significant values upon which to base their decisions and would carry more "scientific weight".

References

Pielke, R. A., and N. Waage 1987: "Note on a Definition of Normal Weather." *National Weather Digest,* Vol 12, No. 3, 20-22.

Panofsky, H. A., and G. Brier 1968: Some Application of Statistics to Meteorology. The Pennsylvania State University.

Faiers, G.E. 1988: "Defining Normal Precipitation," *National Weather Digest,* Vol 13, No. 1, 20-21.

San Francisco Seasonal Precipitation
1959-1960 to 1988-1989

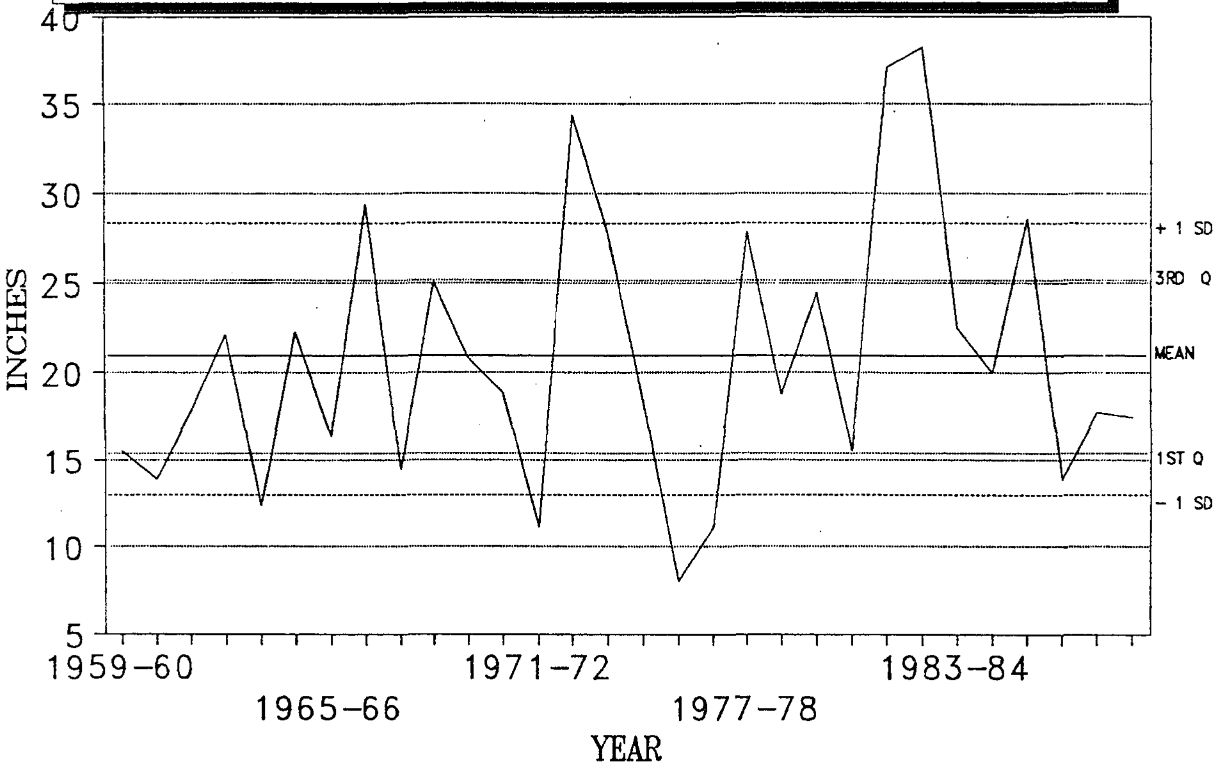

FIGURE 1

San Francisco Precipitation
1877-1878 to 1988-1989

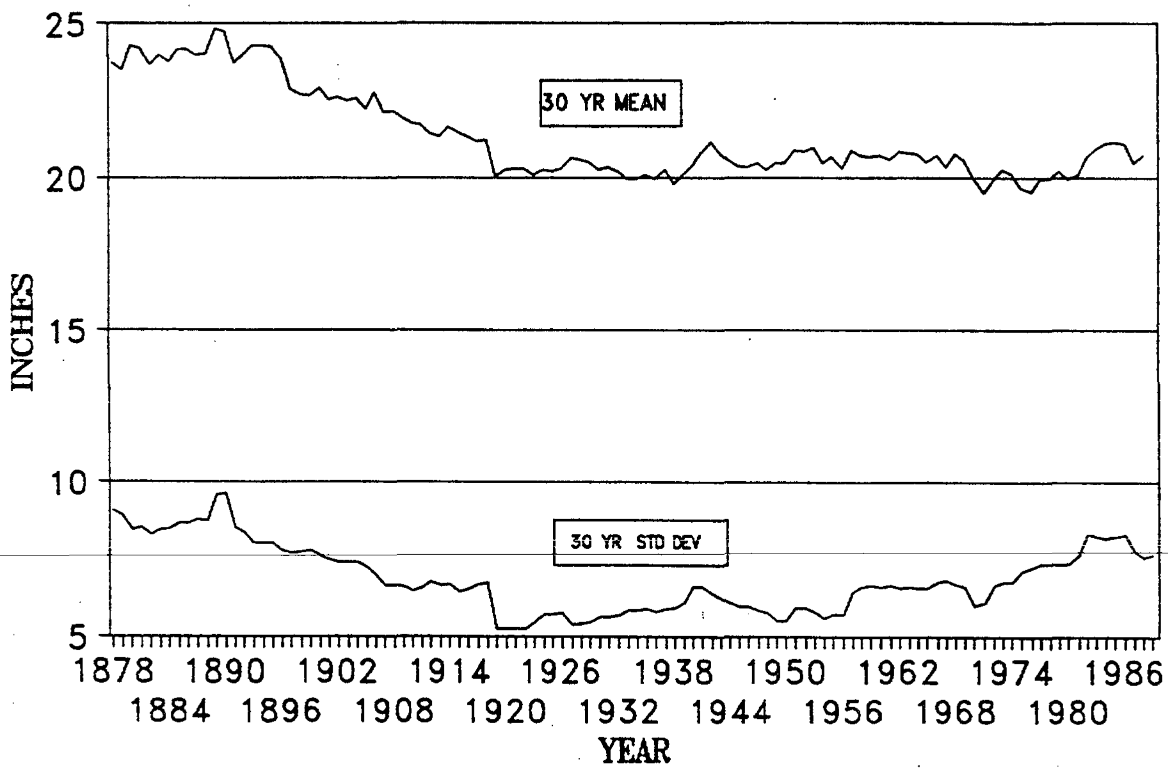

FIGURE 2