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Tornadoes West of the Divide: A Climatology

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Severe Weather

TORNADOES WEST OF THE DIVIDE: A CLIMATOLOGY

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ABSTRACT

A climatology of tornado occurrence west of the Continental Divide is presented. These tornadoes are a small but significant part of severe weather occurrences over the United States. Data are examined from both the spatial and temporal point of view. The influence of population and topography is highly evident.

1. INTRODUCTION

More than 98 percent of the tornadic activity over the continental United States occurs east of the Continental Divide. Consequently, the focus of research and operational efforts has centered on "classic" tornado situations. Nevertheless, tornadic activity west of the Continental Divide poses a threat to aviation and public interests.

Standard climatologies of tornado occurrence, e.g., Schaefer (1) Kelly (2), Court (3) and Pautz (4), tend to glance briefly at or ignore western U.S. activity. Maddox (5) examines severe convective occurrences, including tornadoes, west of 105 degrees west longitude for the period 1955 to 1972.

Using data extracted from the records of the National Severe Storms Forecast Center (SELS log) for the period 1950 to 1978, this paper summarizes a climatology of tornado occurrence west of the Continental Divide. The data are an updated version of data used by Kelly (2). Reference is made to that paper for details of data collection and filtering methods.

2. LOCATION

Tornadoes have occurred in every state on or west of the Continental Divide. Figure 1 shows this occurrence by state. Arizona is the most active state with 97 tornadoes during the 29 year period. Only 10 people have been killed by tornadoes in this area, less than 1 percent of all tornado related deaths across the country. Six of these ten were killed in one tornado in Vancouver, Washington, in 1972. The low casualty count is most likely due to the combination of lower population densities west of the Divide, as well as the lower frequency of tornadoes.

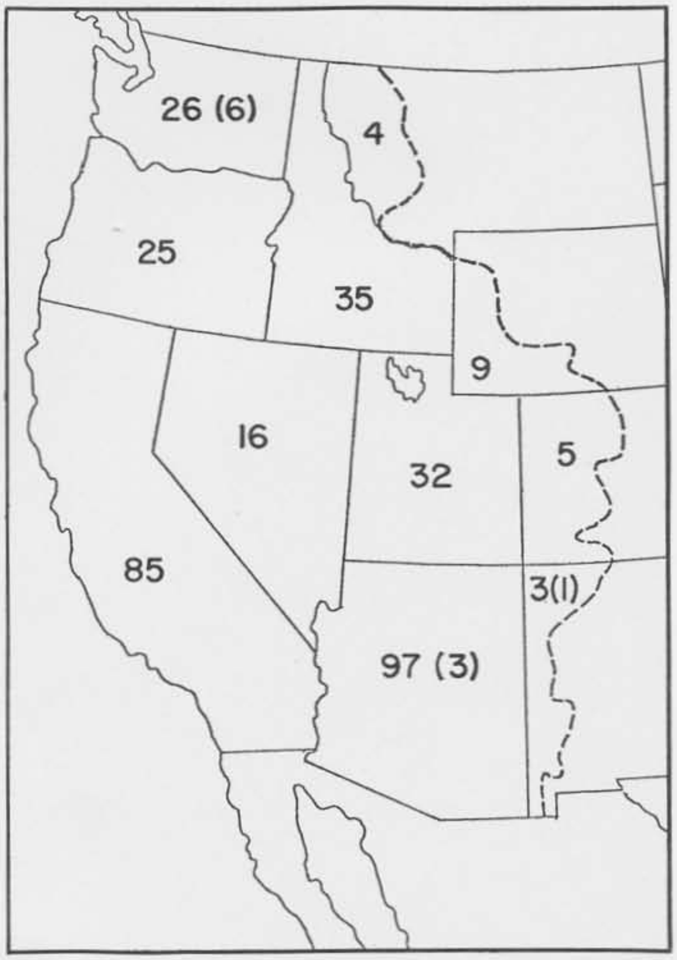

Figure 1. The number of tornadoes touching down in each state west of the Divide, and the number the number deaths attributed to tornadoes (in parentheses), 1950-1978.

Figure 2 shows the location of each of the 337 tornadoes which occurred during the period 1950-1978. Tornado location is visibly a function of both population and topography. The large cluster of reports around Phoenix is highly population influenced compared to the remainder of Arizona. The vast majority of activity has been observed over the lower elevations; specifically, eastern Washington, the Snake River Valley in Idaho, Salt Lake area, the Sacramento and San Joaquin Valleys, the Los Angeles area and southern Arizona.

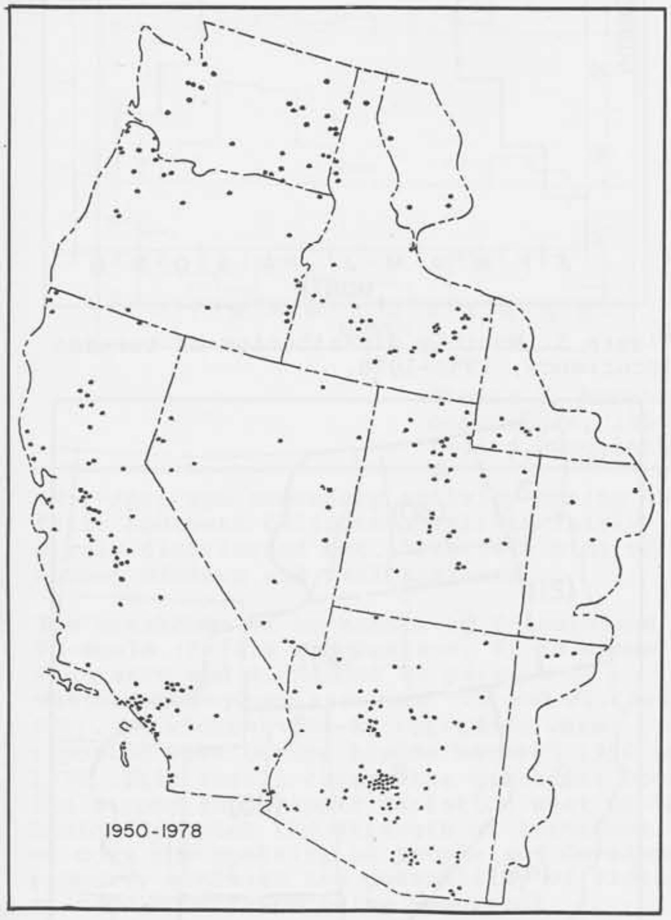

Figure 2. The location of tornado touchdowns west of the Divide as extracted from the SELS log, 1950-1978.

The effect of highways on tornado reporting is seen in central Utah and central Arizona (refer to Figure 3). Route 89 south out of Salt Lake City towards Bryce Canyon National Park and onward to Las Vegas accounts for the string of tornadoes north-south in central Utah. Similarly, the east-west line of reports from Kingman to Winslow and east in Arizona is along Interstate 40.

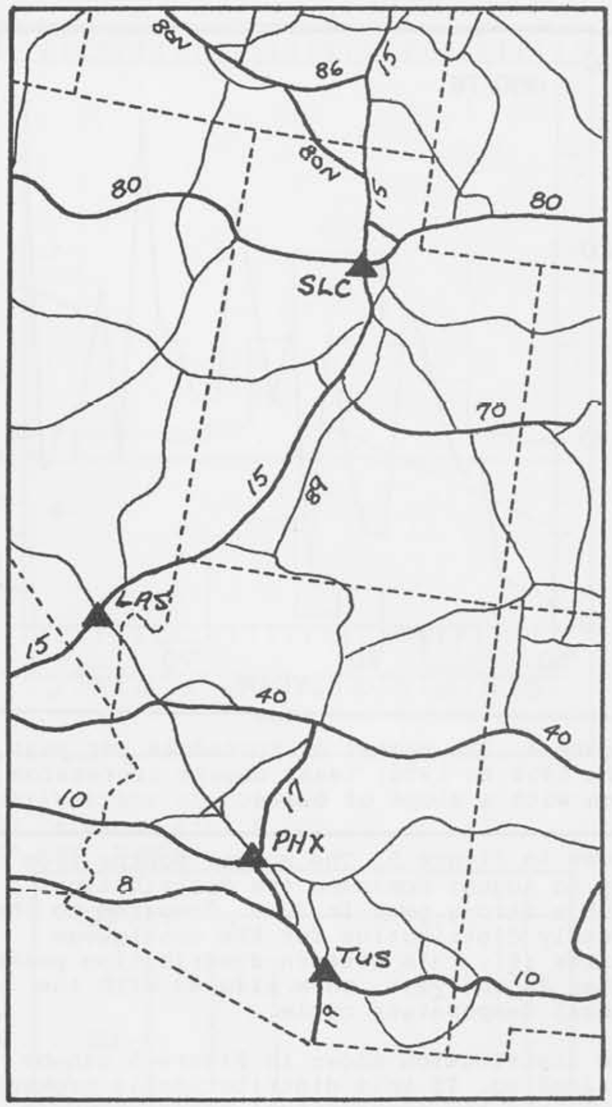

Figure 3. Major highways in Utah and Arizona; interstates (bold lines with route numbers), state highways (thin lines).

The lack of tornadoes over some of the higher terrain, e.g., central Nevada, may be somewhat misleading. Personnel working in the test ranges in south and central Nevada often see tornadoes but these funnels never make it into weather records.

3. BY TIME, ETC.

The trend in tornado occurrence west of the Divide has been upward during the 29 year period of the study. Figure 4 shows the yearly occurrence of tornadoes and a least squares fit to the data. Despite the large yearly variability, tornado activity has been increasing at a rate of about 1 tornado every two years, considerably less than the 21 per year for the nation as a whole (6).

The distribution of tornadoes by month is

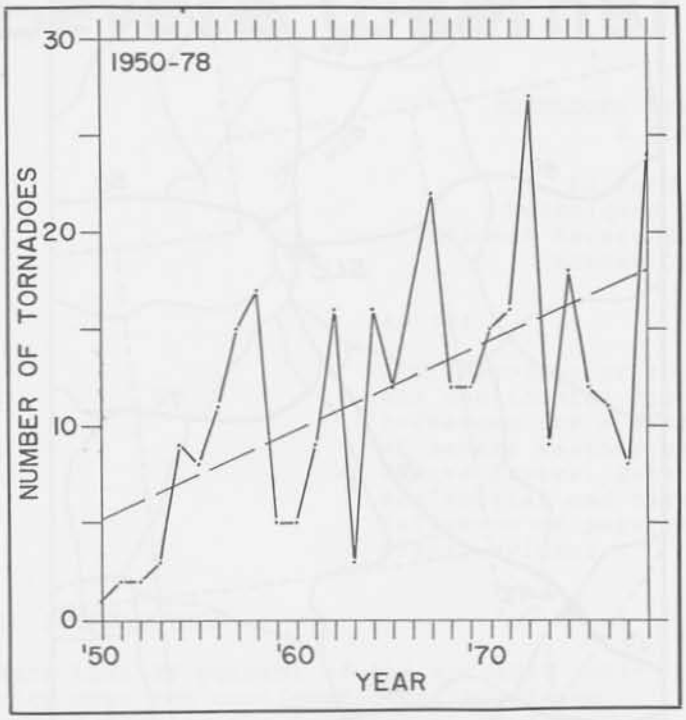

Figure 4. The number of tornadoes per year from 1950 to 1978; least square regression line with a slope of 0.464.

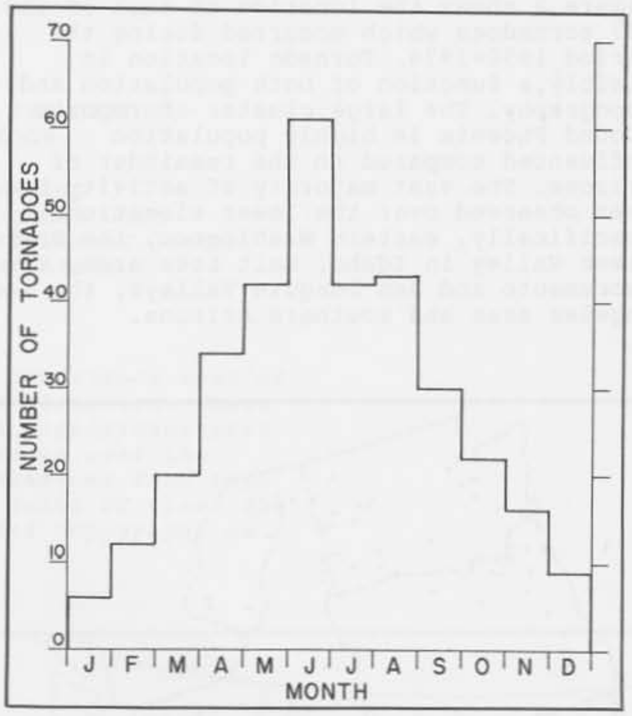

Figure 5. Monthly distribution of tornado occurrence, 1950-1978.

shown in Figure 5. The summer months from May to August dominate the distribution, with a strong peak in June. Compared to the monthly distribution for the contiguous states (6), this western distribution peaks later in the year, more aligned with the annual temperature cycle.

The distribution shown in Figure 5 can be misleading. If this distribution is broken down into the geographical areas shown in Figure 6, substantial regional differences become evident (Figure 7). The areas are chosen to represent the variety of topographies which exist west of the Divide. In some of the distributions the small number of tornadoes in the sample must be kept in mind.

The influence of the Arizona "summer monsoon" (Bryson and Lowry, 7) is very obvious in distribution #7. It is the dominant synoptic feature of the summer tornado season. The interior highlands (#6) and Snake River Valley (#5) peak in June, apparently making use of maximum insolation available at this time of year. The eastern Washington area (#4) peaks a little earlier than the interior, in May, more in line with the nationwide distribution. The coastal northwest (#3) has the smallest number of tornadoes (21) with a tendency for most activity during the fall. Northern California (#2), for the most part the Sacramento and San Joaquin Valleys, has a bimodal distribution with a strong spring peak

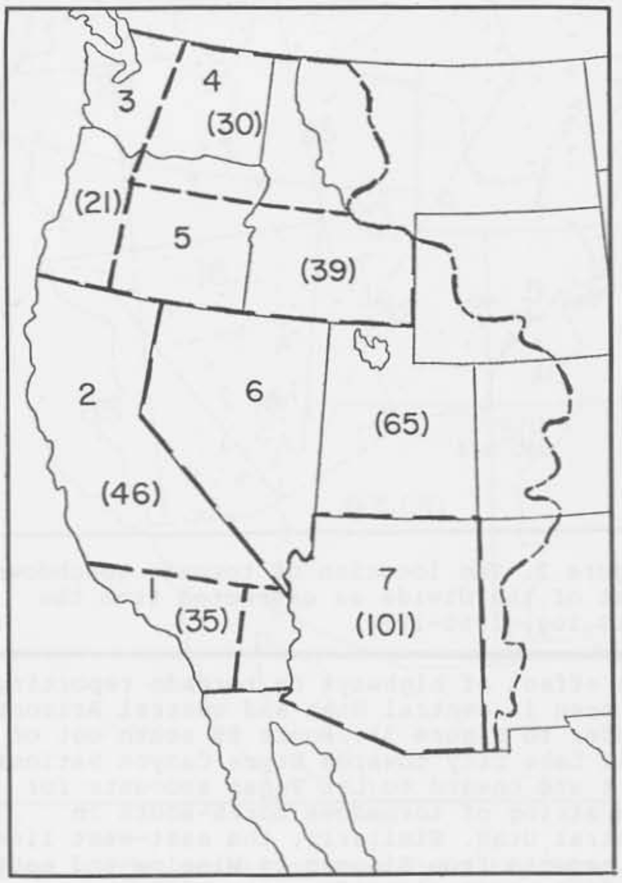

Figure 6. Geographical regions for distributions in Fig. 7; number of tornadoes in each area (in parentheses).

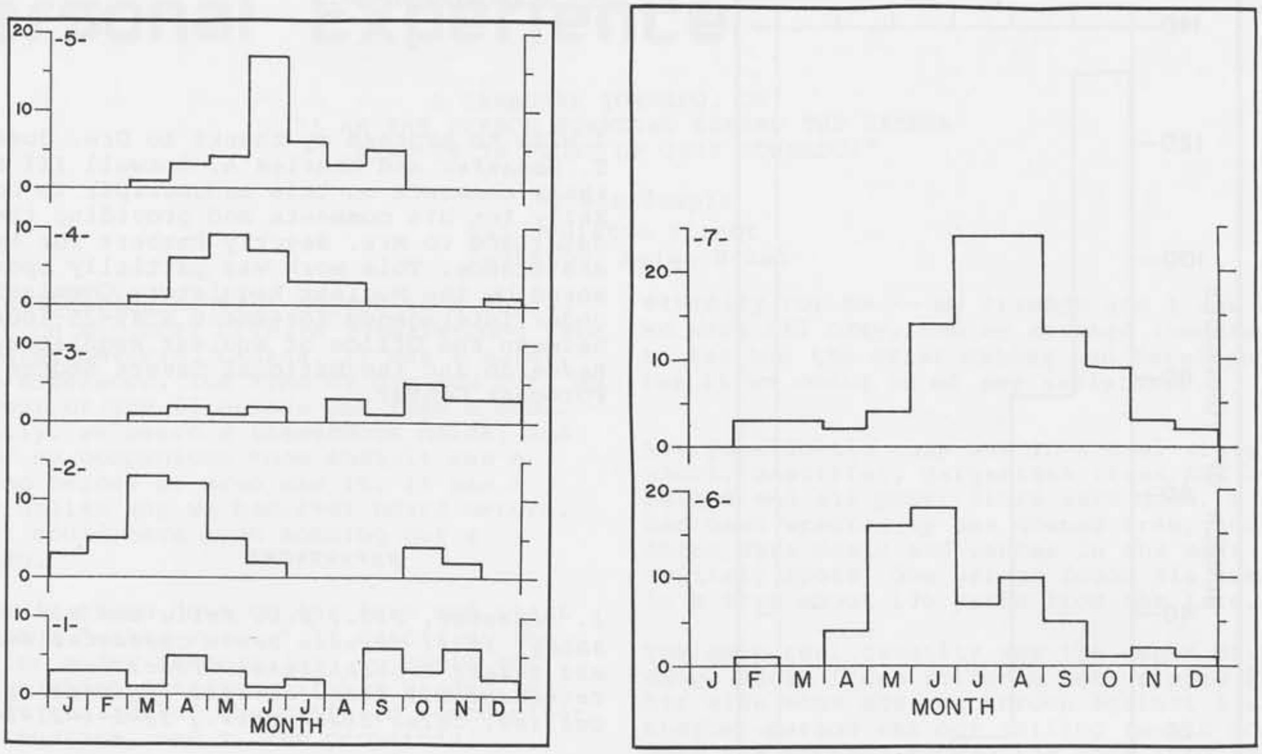

Figure 7. Monthly distributions of tornado occurrence, 1950-1978; refer to Fig. 6 for region associated with each number.

(Mar-Apr) and secondary activity during the fall. Southern California (#1) is fairly evenly distributed but there is a hint of a summer minimum and fall maximum.

The breakdown of tornadoes by F-scale and PL-scale (Fujita and Pearson, 8) is shown in Figures 8 and 9. Almost 80 percent of western tornadoes are weak (F0 and F1, Ref. (2)). No violent (F4-5) tornadoes were reported west of the Divide between 1950 and 1978. This result raises the question: Does the strong topographic variation west of the Divide diminish the strength of tornadoes, or does the sparsity of people and developed property minimize the possibility of violent tornado occurrence being reported?

Figure 9 shows that western tornadoes have shorter paths than tornadoes over the remainder of the country. Using the classification scheme of of Kelly (2), 86.0 percent are short (PL 0-1) (compared to 73.9 percent for the nation), 13.2 percent are intermediate (PL 2-3), and 0.8 percent are long (PL 4-5). Of the two long tornadoes, one occurred in Arizona in 1971 (32 miles long) and the other in Washington in 1958 (45 miles long).

No tornado outbreaks as defined by Galway (9) have occurred west of the Divide. A mini-outbreak of six tornadoes occurred in Arizona on 21 June 1972.

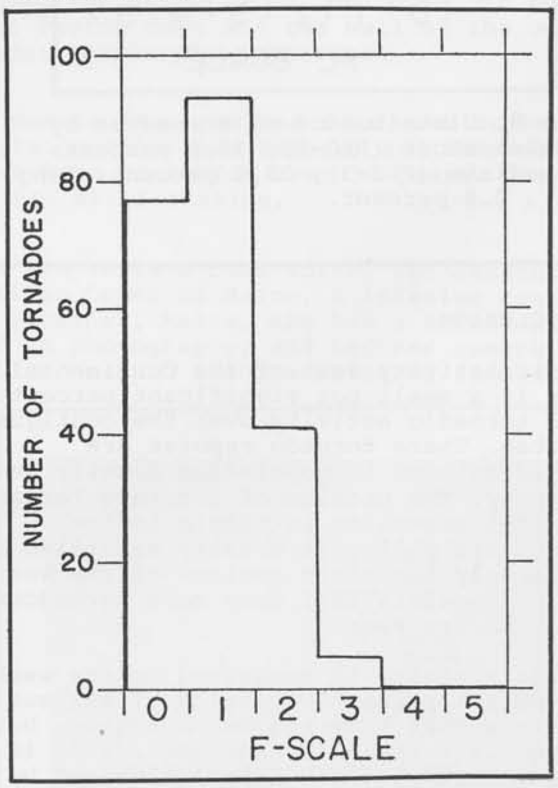

Figure 8. Distribution of tornadoes by F-scale: weak (F0-1), 78.7 percent; strong (F2-3), 21.3 percent; violent (F4-5), 0 percent.

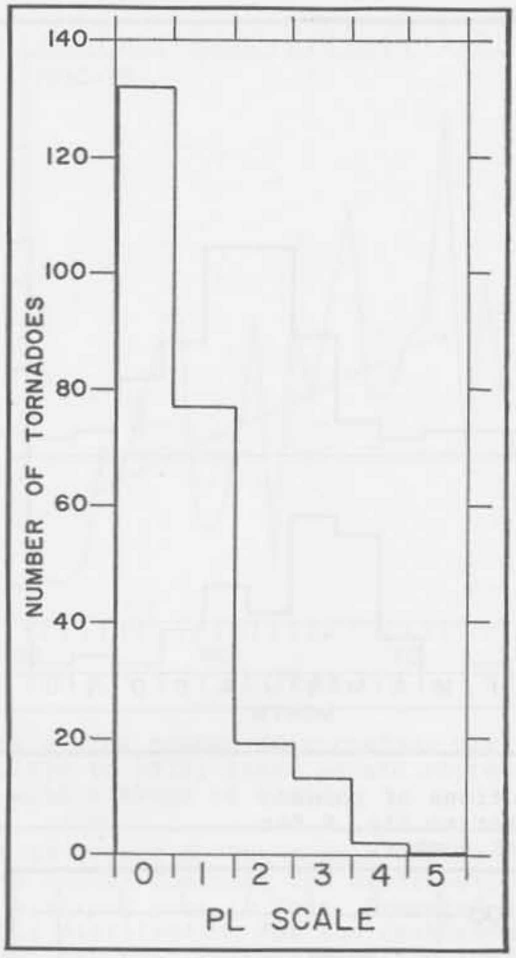

Figure 9. Distribution of tornadoes by PL-Scale: short (PL0-1), 86.0 percent; intermediate (PL2-3), 13.2 percent; long PL4-5), 0.8 percent.

4. CONCLUSION

Tornadic activity west of the Continental Divide is a small but significant percentage of all tornadic activity over the contiguous 48 states. These tornado reports are strongly related to population density and topography. The problem of accurate tornado reporting, something intrinsic to the country as a whole, is greatly magnified in the sparsely inhabited regions of the west. One can speculate that many more tornadoes occur than are seen.

Tornadic activity is dominated by the weak, short-path tornado. The period of maximum activity varies from region to region, but the overall peak in tornado occurrence is during the summer, strongly influenced by the Arizona "monsoon". Over the 29 year period, a slow increase in tornadic activity has occurred, averaging about 1 more tornado every two years.

5. ACKNOWLEDGEMENTS

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