THE CONSISTENCY OF F-SCALE RATINGS

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1. INTRODUCTION

The Fujita or F-scale is the currently accepted damage scale used to classify tornadoes. The scale is primarily based upon a comparison of tornado damage with a set of tornado damage photos (Fig. 1) involving suburban structures on block foundations built using 1970s construction standards. Since the damage caused by tornadoes is a function of wind speed, duration of the strongest wind, presence of flying debris, construction, and what the tornado actually hits, etc., an F-scale rating by its very nature is quite subjective.

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2. NWS TORNADO DATA COLLECTION PROCESS

Because of this subjectivity, there is a basic inconsistency in F-scale ratings between observers. To explore this, the F-scale ratings in the SPC tornado database (Schaefer and Brooks, 2000) are examined. The data is divided into three different time periods differentiated by the procedures used in estimating the F-scale.

As noted by Kelly et al. (1978), during the period 1950-76, most F-scale estimates were obtained by reading local newspaper accounts of storms. In the late 1970s, the NWS made an F-scale estimate part of the tornado report. Each NWS forecast office collected this data for its area of responsibility, typically its state. Such statewide collection of tornado reports was the typical rule during the period 1977-96. In the late 1990s, the

Figure 1: F-scale Rating Sheet used as the primary basis of F-scale rating (based upon Fujita, 1971).

NWS was reorganized into its present configuration with approximately 120 Weather Forecast Offices (WFOs) across the country. Each WFO has a Warning Coordination Meteorologist (WCM) who is responsible for the collection of tornado data, including F-scale estimates, in the counties assigned to the office. Data from the period 1997-2001 was designated as being in the “modernized NWS” era. A further discussion of the changes in tornado data collection procedures can be found in Schaefer et al. (2002) and McCarthy (2003).

Please note that, in actuality, the change from one set of procedures to another occurred over a span of a few years. But for statistical purposes, the dates selected serve to categorize the official tornado record according to the F-scale data collection procedures.

3. TORNADO INTENSITY BY COUNTY

For each county[1] in the contiguous United States, the number of tornadoes that occurred during each of the three time periods (1950-76, 1977-96, and 1977-2001) was tallied. These tornadoes were then grouped by their reported F-scale. The categories are “weak” (F0 and F1), “strong” (F2 and F3), and “violent” (F4 and F5). Maps showing county-by-county distribution of the percentage of tornadoes in each category were then plotted (Fig. 2 through Fig. 4).

4. CHANGES WITH TIME

Very distinct and systematic changes in the F-scale distribution are apparent between the time groupings. The percentage of tornadoes classified as weak increased from the “newspaper” era to the “state office” era. This increase was most pronounced west of the Mississippi, with the exception of Oklahoma, and in the Northeast (Fig. 2a and 2b).

This increasing percentage of weak tornadoes continued between the state office era and the “modernized NWS” era.” This second change was most pronounced in Oklahoma eastward through Alabama (Fig. 2b and 2c). Interestingly enough, the increase was not very pronounced in Missouri, Kentucky, Tennessee, Georgia, and southeastern Mississippi.

As would be expected, the increasing trend to report weak tornadoes has been accompanied by a decreasing percentage of reported violent tornadoes. In the early years, many counties between the Rockies and the Appalachians received violent tornadoes (Fig. 4a). In contrast, during the past half-decade, there were

1 In this presentation, the term county also includes parishes and independent cities.

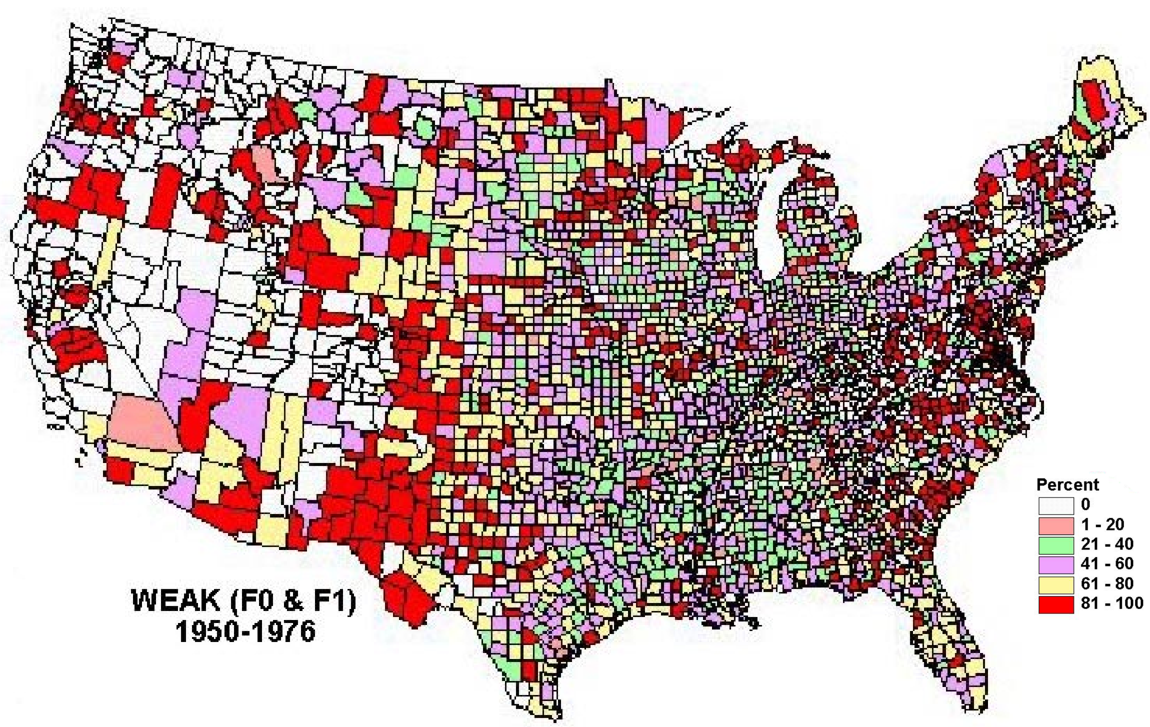

Figure 2a: Percent of tornadoes during the period 1950-1976 in each county that were rated as Weak (F0 & F1).

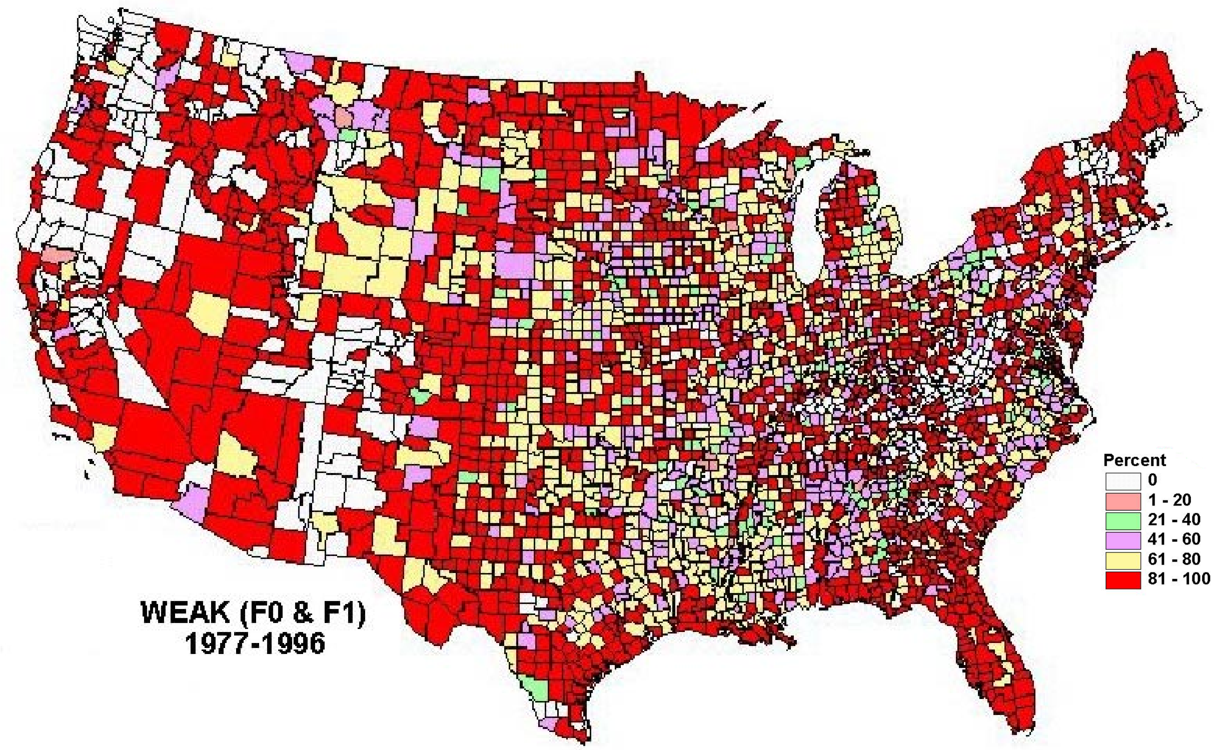

Figure 2b: Percent of tornadoes during the period 1977-1996 in each county that were rated as Weak (F0 & F1).

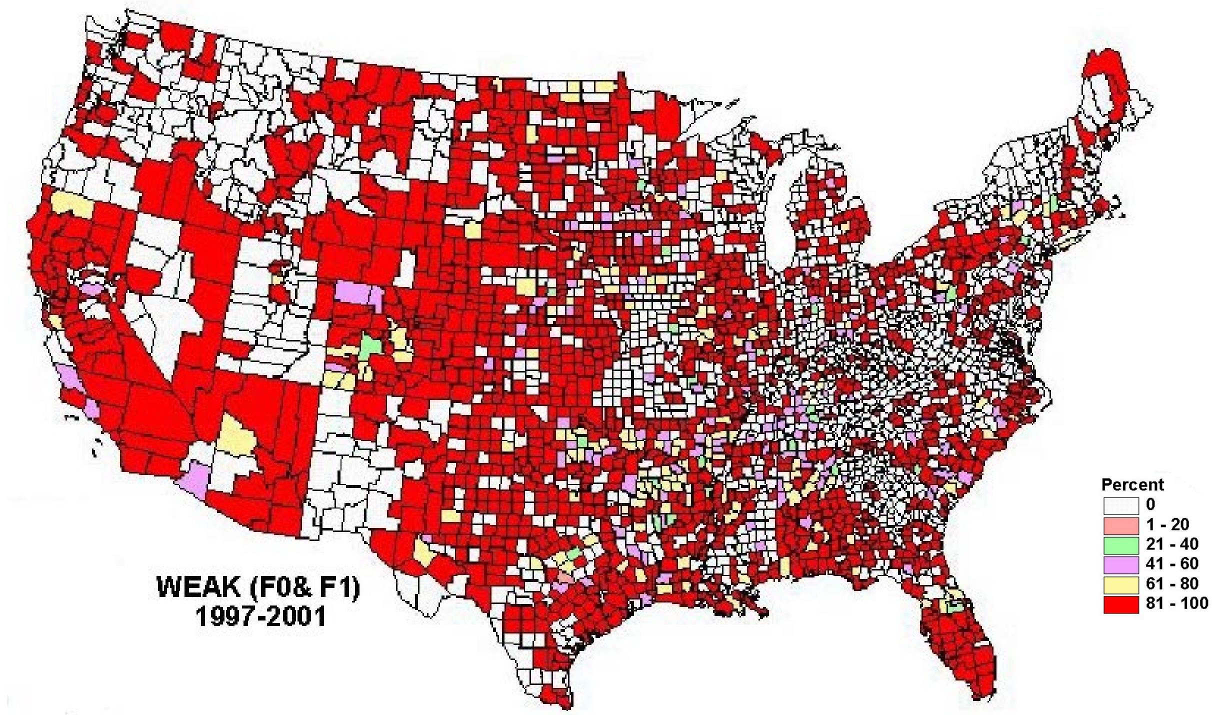

Figure 2c: Percent of tornadoes during the period 1997-2001 in each county that were rated as Weak (F0 & F1).

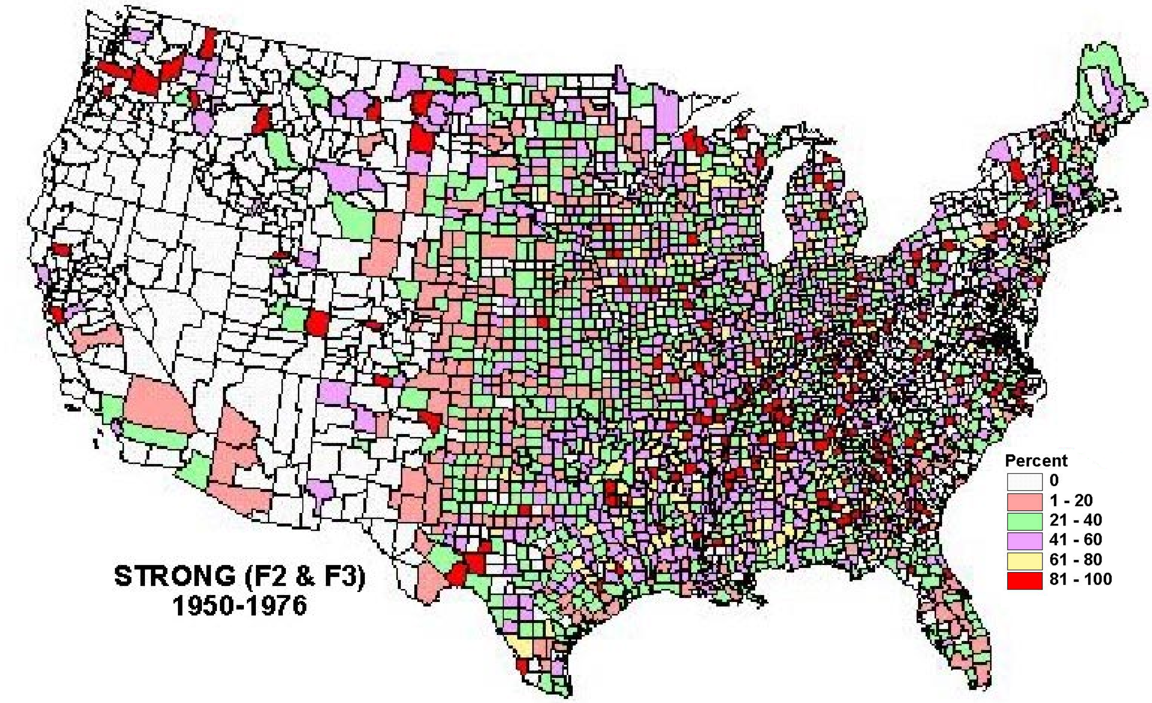

Figure 3a: Percent of tornadoes during the period 1950-1976 in each county that were rated as Strong (F2 & F3).

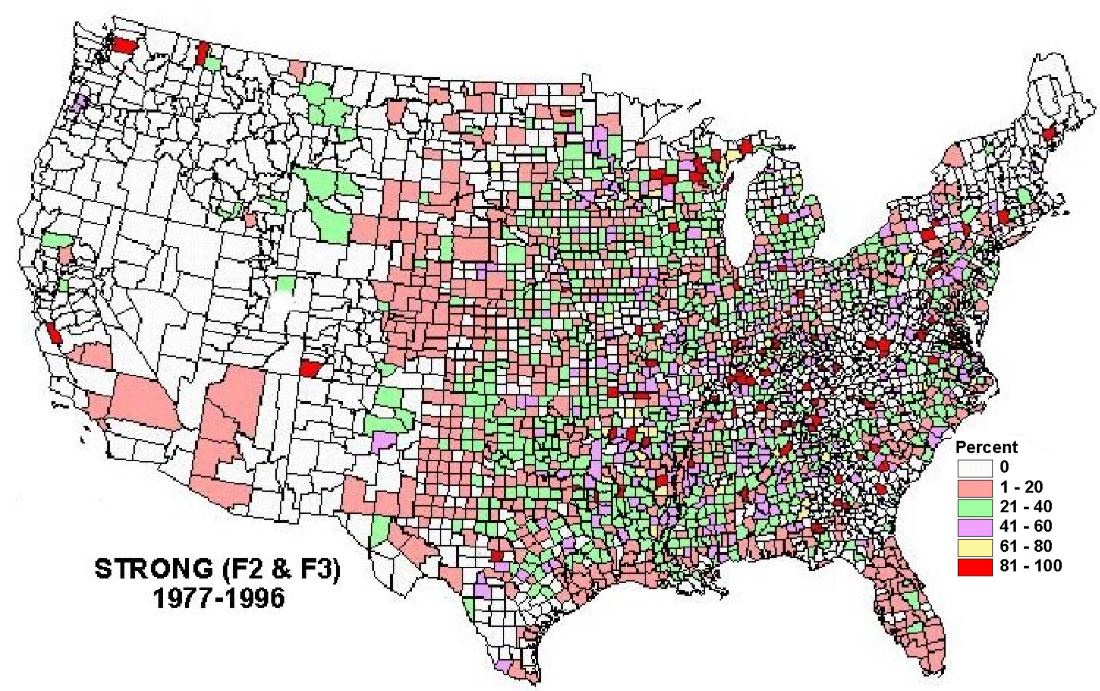

Figure 3b: Percent of tornadoes during the period 1977-1996 in each county that were rated as Strong (F2 & F3).

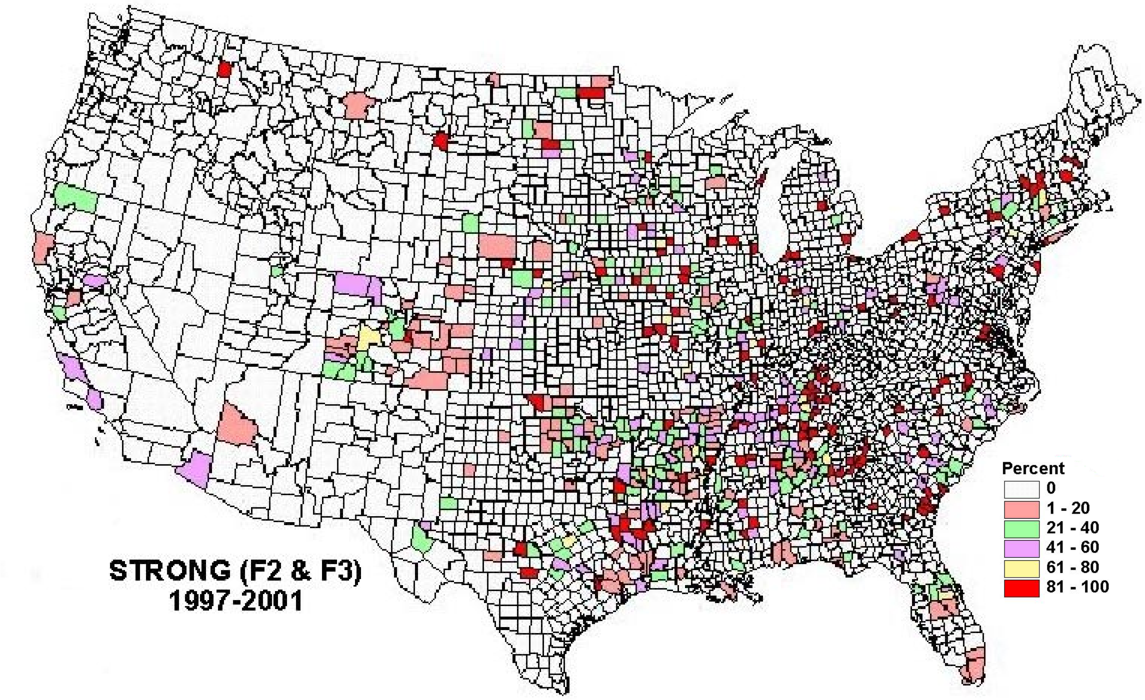

Figure 3c: Percent of tornadoes during the period 1997-2001 in each county that were rated as Strong (F2 & F3).

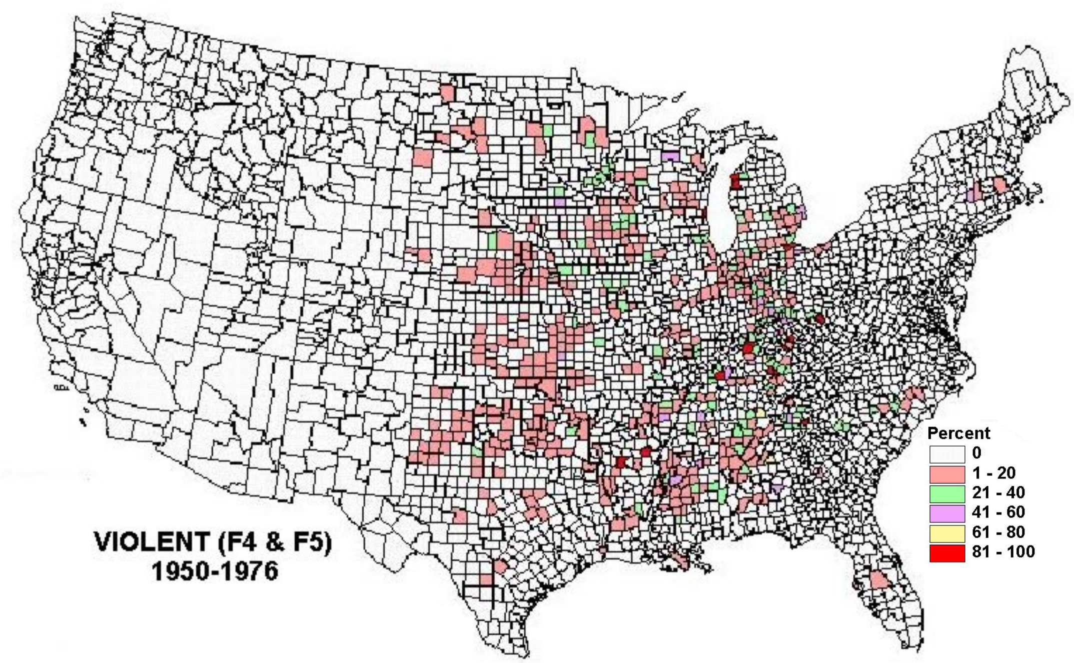

Figure 4a: Percent of tornadoes during the period 1950-1976 in each county that were rated as Violent (F4 & F5).

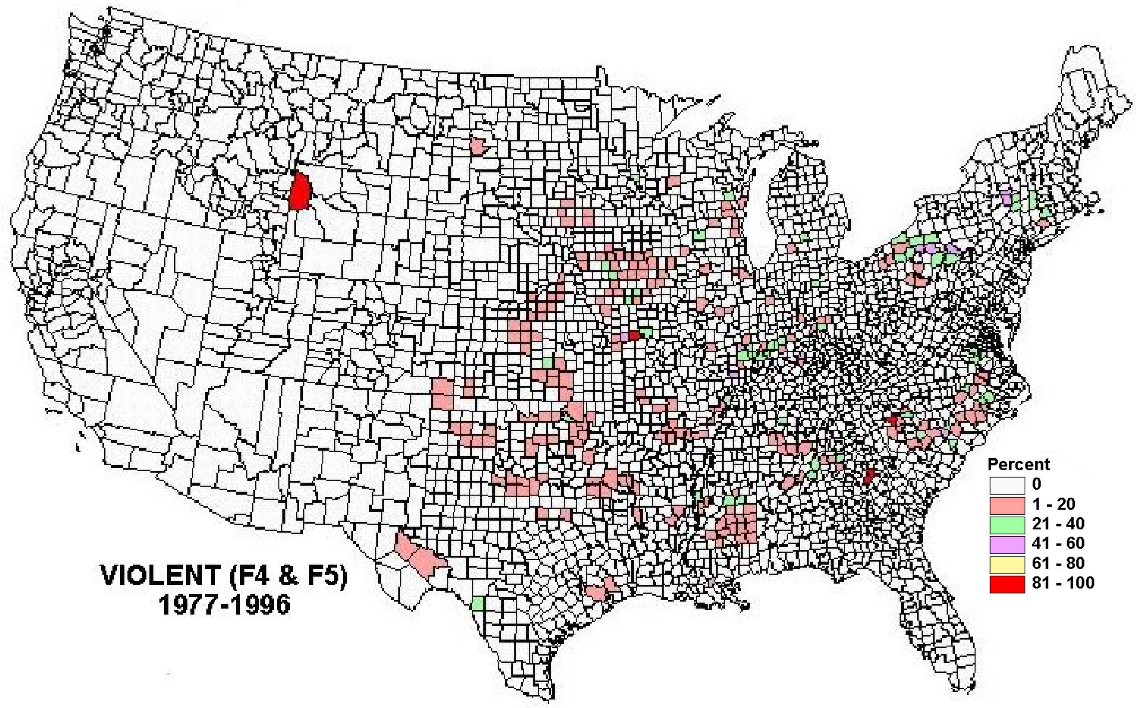

Figure 4b: Percent of tornadoes during the period 1977-1996 in each county that were rated as Violent (F4 & F5).

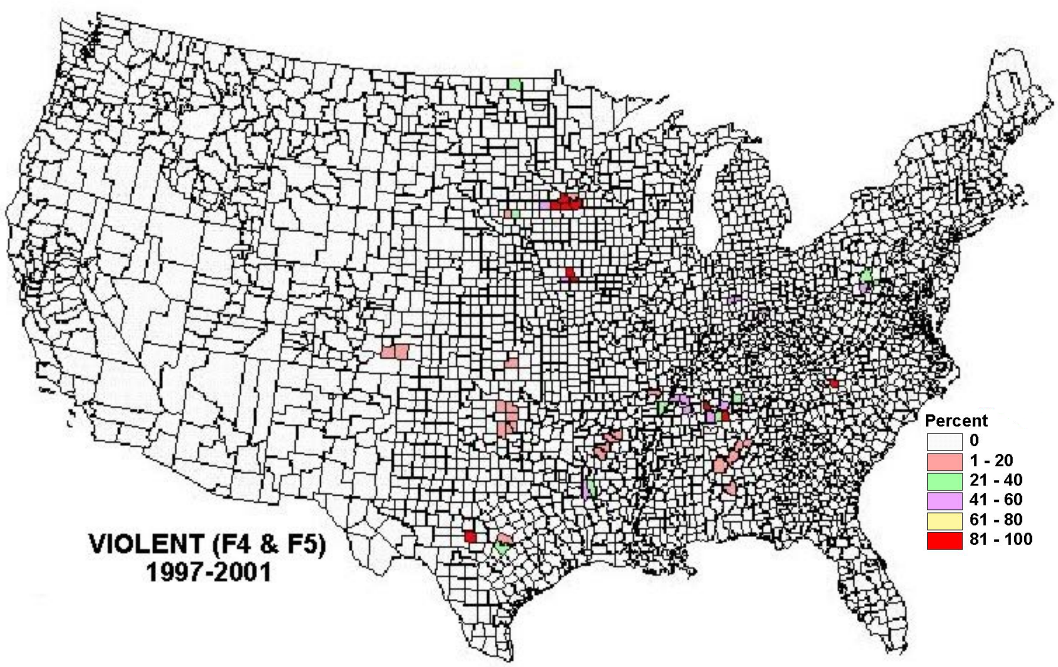

Figure 4c: Percent of tornadoes during the period 1997-2001 in each county that were rated as Violent (F4 & F5).

very few counties with violent tornadoes scattered across the country (Fig. 4c).

Perhaps the most interesting temporal changes occurred with strong tornadoes. In the newspaper era, a relatively random scattering of colors indicates no areas of preferred strong tornado reporting over a large portion of the Southeast containing most of Arkansas, Louisiana, Tennessee, Mississippi, Alabama, and Georgia (Fig. 3a). During the state office era, the size of this heterogeneous area decreased as Georgia and middle and eastern Tennessee received proportionately fewer strong tornadoes (Fig. 3b). After the NWS modernization, the only vestiges of this area remaining are in Arkansas and western Tennessee (Fig. 3c).

5. DIFFERENCES BETWEEN EVALUATORS

Apparent differences in rating philosophy between different evaluators can be seen on virtually all 9 charts in Figures 2 through 4. For instance, the Missouri-Iowa border coincides with a marked discontinuity on the chart showing strong tornadoes for the state office era (Fig. 3b). This feature is no longer apparent on the chart showing the same data for the modernized NWS era (Fig. 4b). However, this chart shows a distinct difference between the intensity of tornadoes in the central portions of Oklahoma, as compared to the neighboring southern Kansas.

6. DISCUSSION

When making F-scale comparisons, it is essential to remember that there may be meteorological differences at work. However, over generally homogeneous terrain, differences between neighboring areas must be treated with caution and lead one to assert that significant biases are present in the historical record.

It is incumbent upon us, whether we are meteorologists, engineers, or other scientists, to develop a more objective means of applying the F-scale to tornado damage. One possible method would be for a group of experts to develop decision-tree type software to aid in the assessment of tornado damage. Such a program could be developed to run on handheld computer assistants to provide expert assistance to F-scale raters while they are surveying the tornado damage track.

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7. REFERENCES

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