STATE AVERAGES OF SURFACE PARAMETERS ASSOCIATED WITH TORNADOES

Richard J. Williams
National Severe Storms Forecast Center
Kansas City, Missouri 64106

ABSTRACT

Monthly values of surface parameters associated with tornadoes are presented for each state east of the Rockies. The monthly averages were obtained through objective analysis of surface conditons preceding each of over 6,000 tornadoes occurring from 1968 through 1975. The monthly maps provide the operational forecaster with information concerning surface conditions accompanying tornadoes on a month by month basis.

1. INTRODUCTION

Surface parameters associated with over 6,000 tornadoes have been computed objectively at the National Severe Storms Forecast Center. In an earlier article, Williams (1976, denoted hereafter as W) provided an analysis of these data by various regions of the country and seasons of the year. This paper extends the analysis to give monthly average pre-tornado surface conditions for each state east of the Rockies.

2. COMPUTATION OF AVERAGES

NSSFC has compiled a tornado history tape which contains the time and location of occurrence for each reported tornado from 1950 through the present. Since 1968, NSSFC has archived surface weather conditions at 3 hourly intervals from over 500 stations across the country. Using the two sets of data, pre-tornado values of surface temperature, dew point, sea level pressure, wind direction and wind speed have been obtained for most reported tornadoes from 1968 through 1975.

The objective analysis scheme utilizes the weather conditions from the five stations closest to each tornado to determine conditions at the site of the touchdown. No interpolation in time is performed. The three hourly data at or before the occurrence was used in the computation from 1968 through 1974. During 1975, hourly data were available between March and August and were used in the objective analysis.

The analysis scheme applied follows the method described by Endlich and Mancuso (1968) and utilized by Inman (1970). The routine employs a first degree polynomial to fit data from the five observations nearest to the tornado location. The influence of each station report is proportional to its distance from the touchdown location so that stations closer to the tornado carry more weight in the computation.

No parameters were computed west of approximately 110°W. Also, occasional missing surface data on the tape eliminated a number of cases. In all, pre-tornado parameters were computed for about 6,100 out of the 6,876 tornadoes recorded during the 8 year period of study.

As pointed out in W, comparison of the tornado parameters from the automated analysis with manually determined values shows that the two methods are generally in good agreement. The only significant difference was noted in analysis of winds where the manually interpolated wind speeds were considerably higher than those indicated by the objective analysis.

3. STATE AVERAGES

From the pre-tornado surface parameters for individual tornadoes, average conditions can be computed. W provided averages on a regional and seasonal basis. Figure 1 is reproduced from W and shows the state averages for the entire year. This paper amplifies upon this by giving state averages for each month.

Figures 2 through 13 depict the monthly averages for each state. The number of occurrences in each state for the 8 year period is shown at the right side of the plot in parentheses. Temperature and dew point are shown at the left of each plot in degrees Fahrenheit. Sea level pressure in millibars and tenths, with the leading 9 or 10 omitted, is provided in the upper right hand position. Average values for wind speed and wind direction are plotted in the normal manner with wind speed depicted in knots.

Surface parameters are shown only for states having at least 3 tornadoes during the month. Even so, caution should be used when the number of tornado cases in a state is small. The average may have been computed on the basis of a single outbreak or under very unusual conditions.

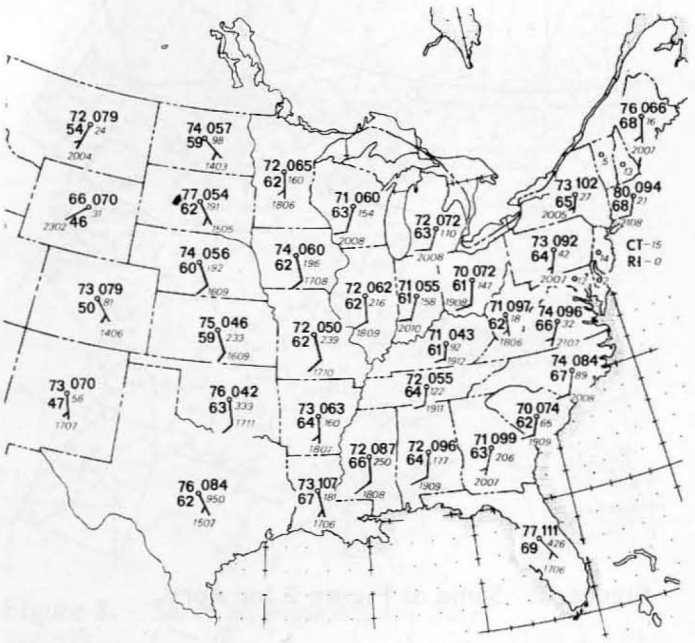

Figure 1. Average surface parameters 0-3 hours prior to tornado. Temperature and dew point at left of plot in °F. Sea level pressure in millibars and tenths at upper right hand position. Winds shown in knots. Number of tornado reports shown at right center position.

In the Northeast some grouping of states was done so that realistic averages could be computed. New Hampshire and Vermont were grouped; Massachusetts, Connecticut and Rhode Island were considered as a unit and Maryland, New Jersey, Delaware and The District of Columbia were treated together. These groupings are shown by the heavier lines on the monthly maps.

The January averages (Figure 2) show that tornado occurrences are concentrated in the southern states. Illinois recorded the 3 tornadoes needed to produce a plot of averages. However, all other northern states had less than 3 occurrences and no averages are shown. Note the lower pressures in the western portion of the map. This pattern of lower sea level pressures in the western states is evident on most of the monthly maps.

The February data (Figure 3) shows the tornado related temperatures in both Illinois and Ohio to be in the upper 50s, well above the normal February value for those states. The 47° temperature and 38° dew point plotted for Oklahoma is the result of the 6 tornadoes near Altus, Oklahoma on February 22, 1975. Those tornadoes occurred in an area of shallow cold air.

In March (Figure 4) pre-tornado pressures still exhibit lower values in western and northern states. The dew points shown from Missouri, Kansas and Kentucky northward are in the upper 40s and 50s. Those values are well below the dew points commonly associated with tornadoes and show that forecasters should not expect dew points in the 60s for early season tornadoes in northern states.

By April (Figure 5) tornadoes have spread through most of the country east of the Rockies with the exception of the Northeastern states. Temperatures range from the low 70s along the Gulf to near 60° in the north. The April averages include the large number of tornadoes in the April 3, 1974, outbreak.

The May averages (Figure 6) show little variation across the country. Temperatures preceding tornado occurrences range from the mid 70s in the south to the upper 60s in the north. Winds show a division generally along the Mississippi River. East of the Mississippi River the winds are from the south southwest while west of the river most winds are from the south southeast.

Figure 7 depicts the June averages. Temperatures have increased to the 70s and low 80s. Note the Maine average temperature of 81° for 4 cases.

July and August tornadoes (Figures 8 and 9) show the highest pre-tornado temperatures. Pressures tend to be higher during the summer months reflecting the absence of well developed low pressure systems.

In September (Figure 10) average values for temperature and pressure begin to lower across the country. By October (Figure 11) tornado occurrences are less common and many states in the north and northeast did not meet the 3 occurrence criteria for displaying an average.

November and December (Figures 12 and 13) show average temperatures mostly in the 50s and 60s. In most states these temperatures are well above the climatological normals for the month. Four out of the five Wisconsin tornadoes shown in December occurred on December 1, 1970. They constituted a rare outbreak for that state and month.

4. CONCLUSION

Other methods of displaying this information may prove useful to local offices and persons interested in tornado formation. For example, a plot of tornado related temperatures month by month can be compared with a plot of average monthly maximum temperatures. For most states, such a plot shows that cold season tornadoes occur with temperatures well above the climatological normal while the summer tornadoes occur with temperatures near or in some cases below average afternoon highs.

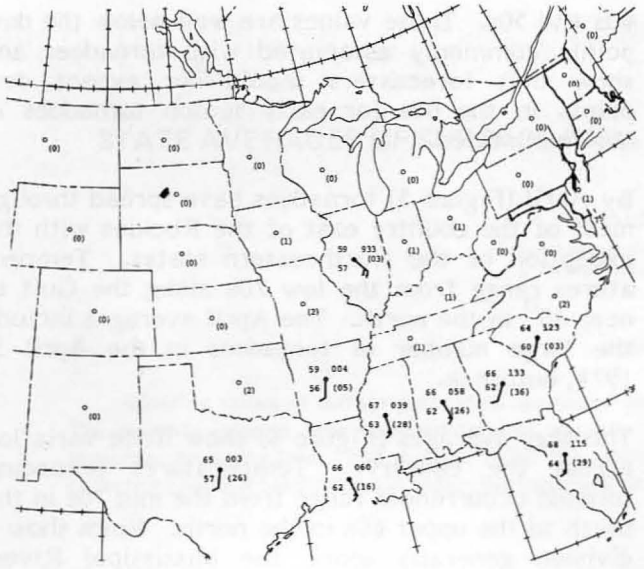

Figure 2. Average surface parameters for January.

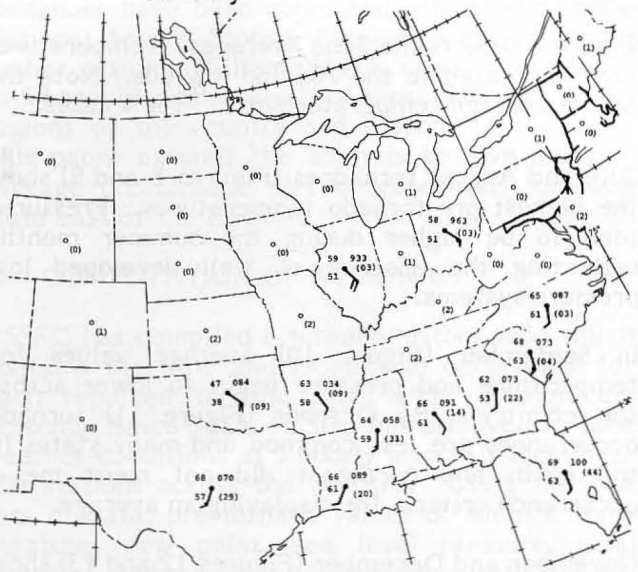

Figure 3. Same as Figure 2 for February.

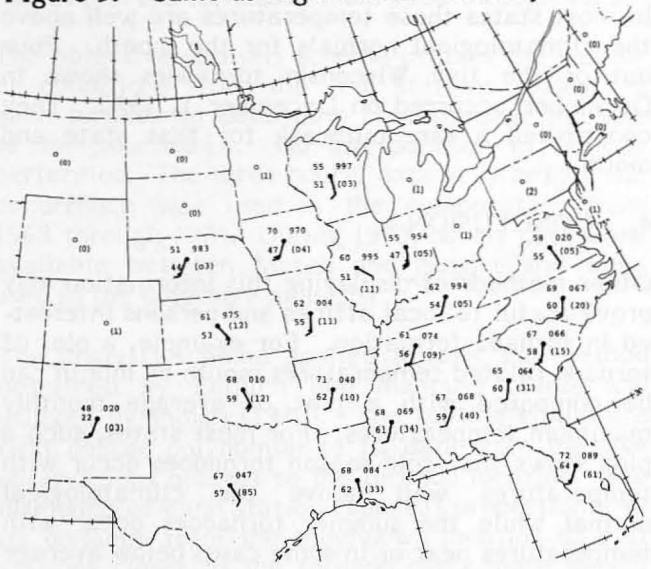

Figure 4. Same as Figure 2 for March.

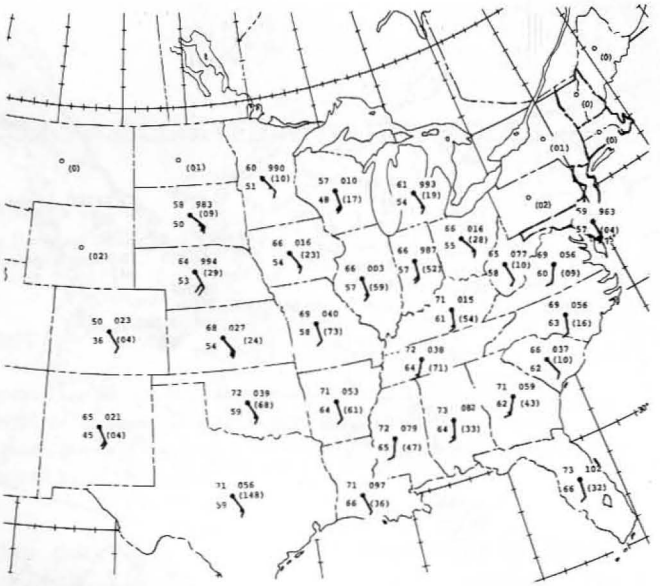

Figure 5. Same as Figure 2 for April.

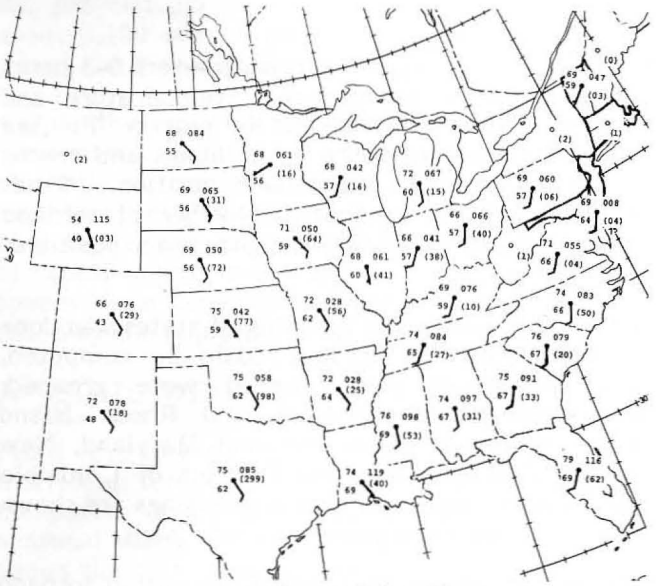

Figure 6. Same as Figure 2 for May.

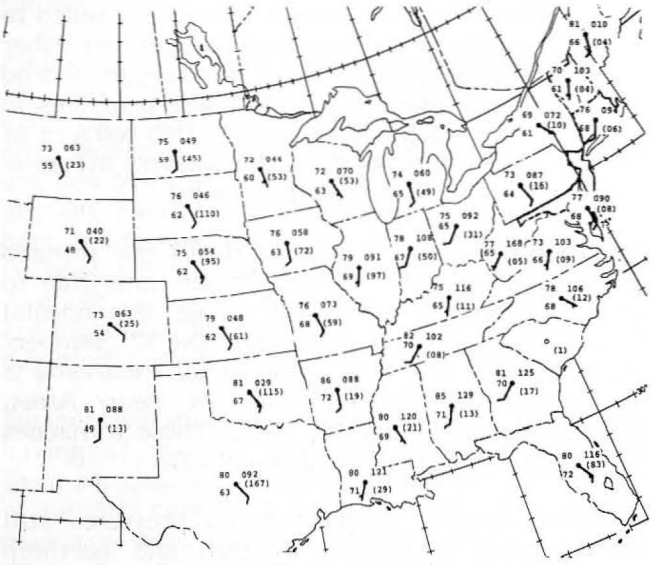

Figure 7. Same as Figure 2 for June.

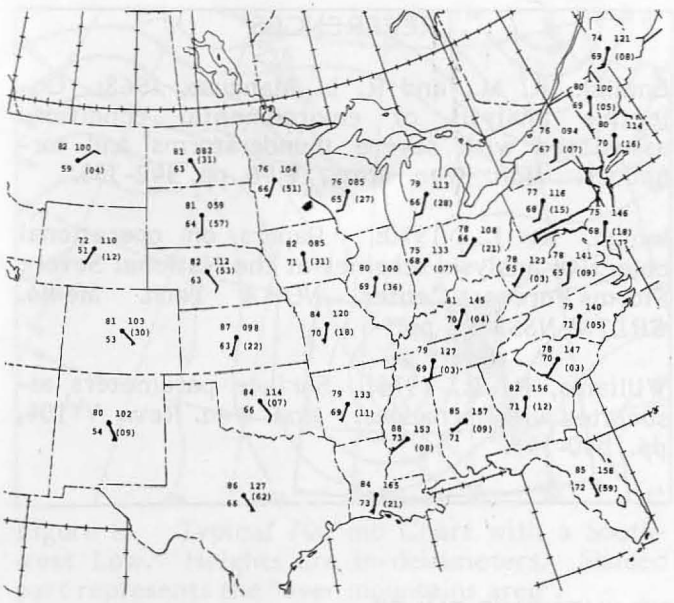

Figure 8. Same as Figure 2 for July.

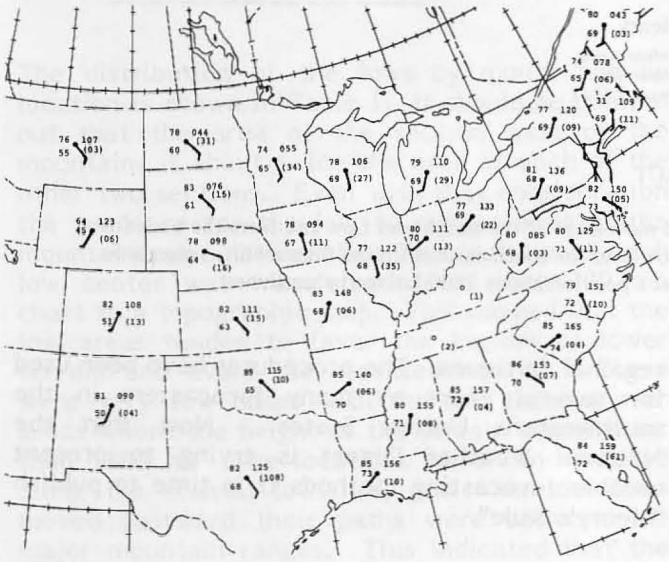

Figure 9. Same as Figure 2 for August.

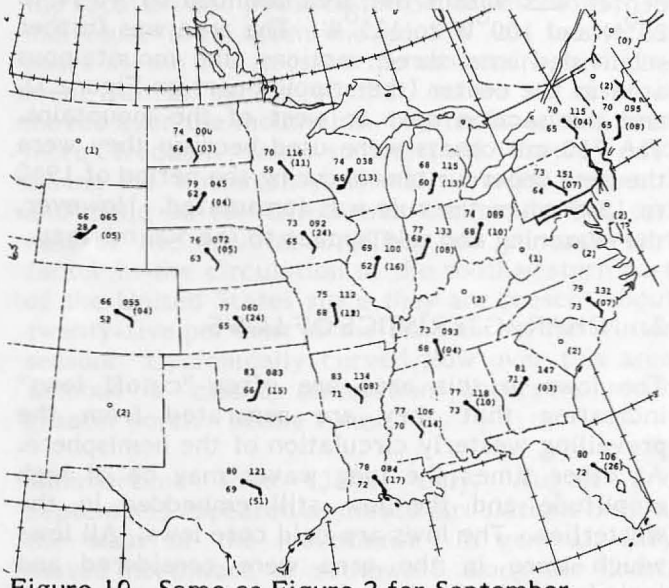

Figure 10. Same as Figure 2 for September.

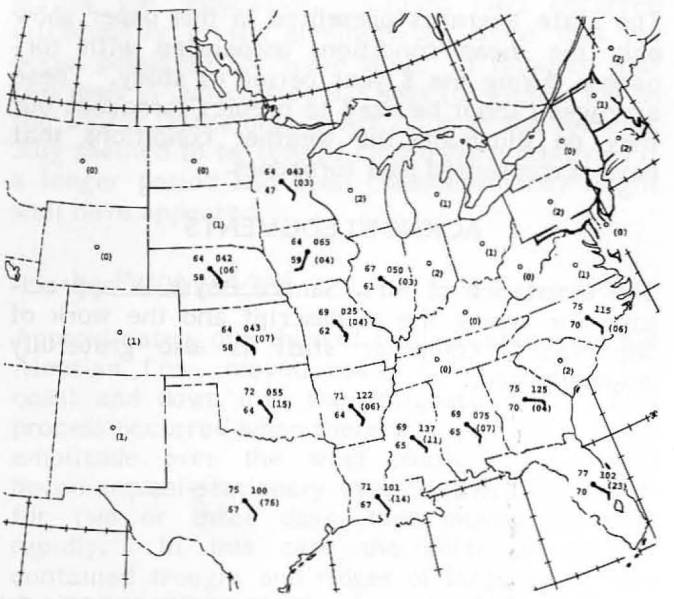

Figure 11. Same as Figure 2 for October.

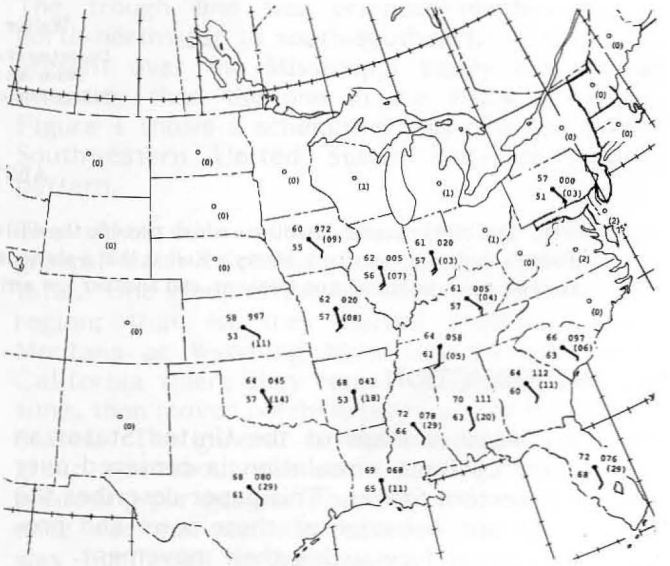

Figure 12. Same as Figure 2 for November.

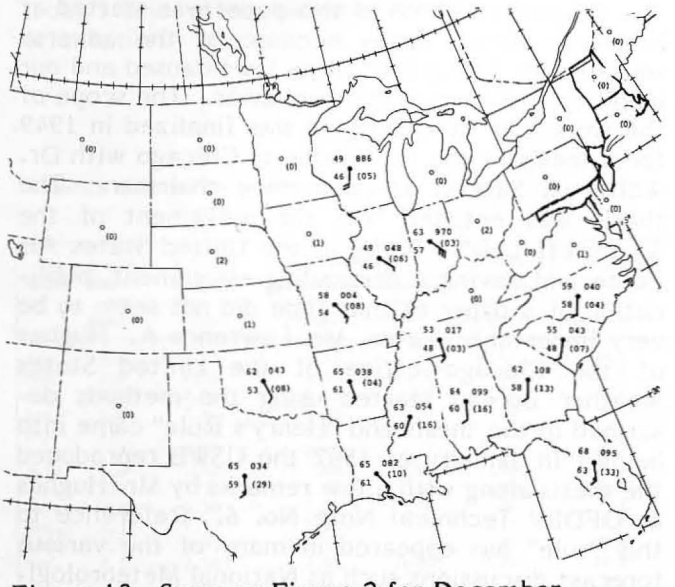

Figure 13. Same as Figure 2 for December.

The state averages presented in this paper show only the mean conditions associated with tornadoes during the 8 year period of study. These averages cannot be used to predict tornadoes but they do illustrate the weather conditions that have accompanied past tornadoes.

ACKNOWLEDGMENTS

The assistance of Mrs. Sandra Boyse is appreciated for typing the manuscript and the work of the NSSFC computer staff is also gratefully acknowledged.

REFERENCES

Endlich, R. M., and R. L. Mancuso, 1968: Objective analysis of environmental conditions associated with severe thunderstorms and tornadoes. *Mon. Wea. Rev.*, V 96, pp. 342-350.

Inman, R. L., 1970: Papers on operational objective analysis schemes at the National Severe Storms Forecast Center. *NOAA Tech. Memo. ERLTM-NSSL 51*, pp.

Williams, R. J., 1976: Surface parameters associated with tornadoes. *Mon. Wea. Rev.*, V 104, pp. 540-545.