P8.3 The Climatology and Character of Pennsylvania Severe Weather

John LaCorte and Richard H. Grumm
National Weather Service
State College, PA 16801

1. Introduction

An examination was made of NCDC's *Storm Data* to determine the climatology and character of severe weather in Pennsylvania. All storm reports for Pennsylvania were put into a relational database for easy examination and extraction of data. In this study, only reports directly related to severe and tornadic thunderstorms were used.

SQL was used to construct queries to determine the monthly and seasonal climatology. Additionally, the data lent itself to determine the onset and dissipation time of these events as well as the number of reports associated with each event. Data were binned to find events with a large number of severe weather reports. An occurrence with 25 or more reports seemed to delineate a *large* event from a *small* event. The National Centers for Environmental Predictions (NCEP) reanalysis data were then used to see if there were any large-scale meteorological conditions that could be used to discriminate between a large event and an ordinary or small severe weather event.

Similar to severe thunderstorms, tornado events were stratified to identify the strong and violent tornadic episodes. The NCEP reanalysis data were then used to determine the large-scale meteorological conditions associated with strong and violent tornadic events in Pennsylvania.

*Corresponding author address: Richard H. Grumm, 227 W. Beaver Ave, State College, PA 16803
email: richard.grumm@noaa.gov

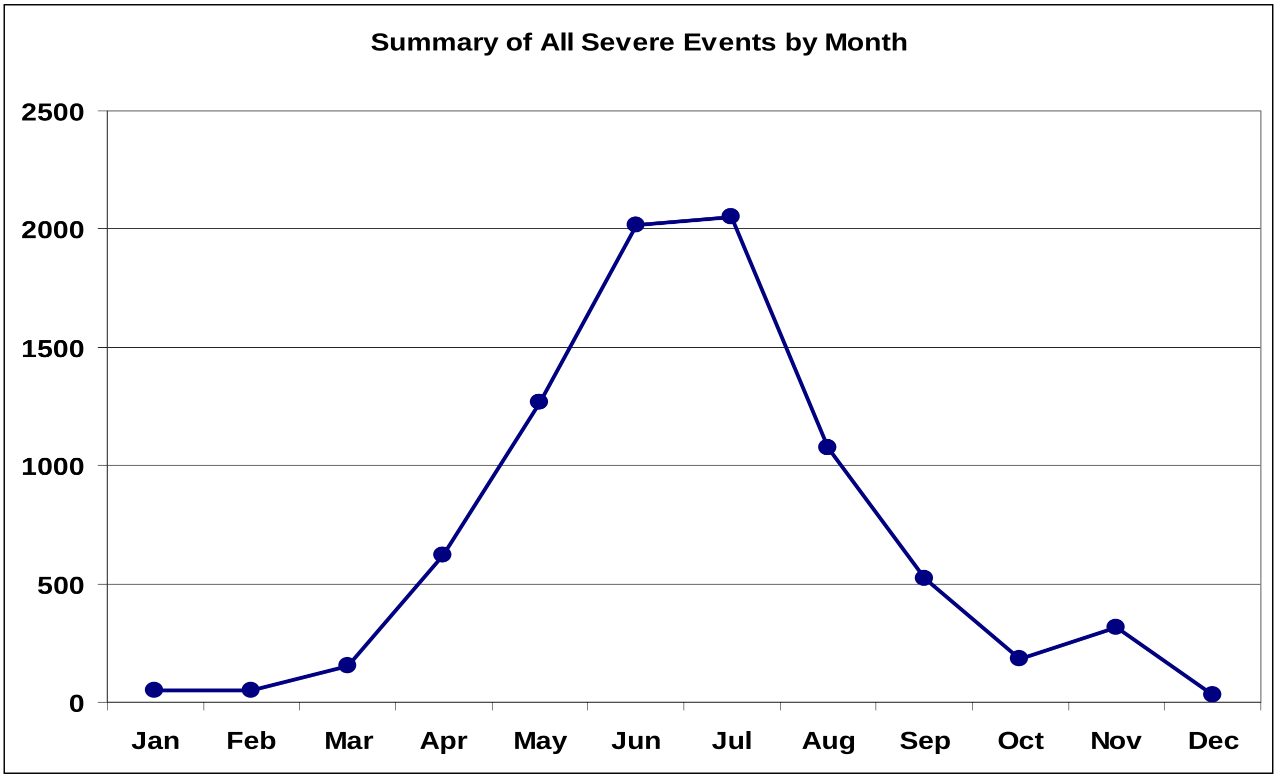

Figure 1. The number of severe weather events by month of the year.

This paper will show the general climatology of severe convective weather over Pennsylvania. The large-scale conditions associated widespread severe weather and violent tornadoes are presented. The goals are to assist the forecaster in anticipating the larger and more violent severe weather episodes and to provide guidance as to the synoptic conditions that may provide an environment for thunderstorms most likely to produce severe weather.

2. Method

The severe weather reports were extracted from Storm Data (available back to 1950). Additionally, some tornado information was taken from "Significant Tornadoes 1680-1991" (Grazulis). These data were then placed into a relational database. SQL was used to construct queries, which allowed for sorting by number of reports for each event, the computation of monthly statistics, the computation of the time of the first and last reports of severe weather during an event, and stratifying tornadic events by F-scale.

The NCEP reanalysis data were used to determine the large-scale meteorological conditions associated with each event. The reanalysis data were displayed using GrADS as in Grumm and Hart (2001). All parameters were displayed showing fields such as the 850 hPa u-wind component and the number of standard deviations the field departed from its 30-year climatological value.

3. Results

The number of severe weather events by month is shown in Figure 1. These data show the well-known winter minimum in severe weather with a rapid increase in the number of severe weather events from March through June. June and July are the two most active months. Severe weather events drop off from July to December with a slight hint of a secondary maximum in November.

Figure 2 shows the frequency of severe weather binned by the number of reports comprising the event. These data show that majority of severe weather events are associated with a small number of reports. For example, approximately 70% of events resulted in just 5 or fewer reports of severe weather. The truly unique events are often associated with 40 or more reports of severe weather.

An examination was made of the number of reports of severe weather associated with several of the

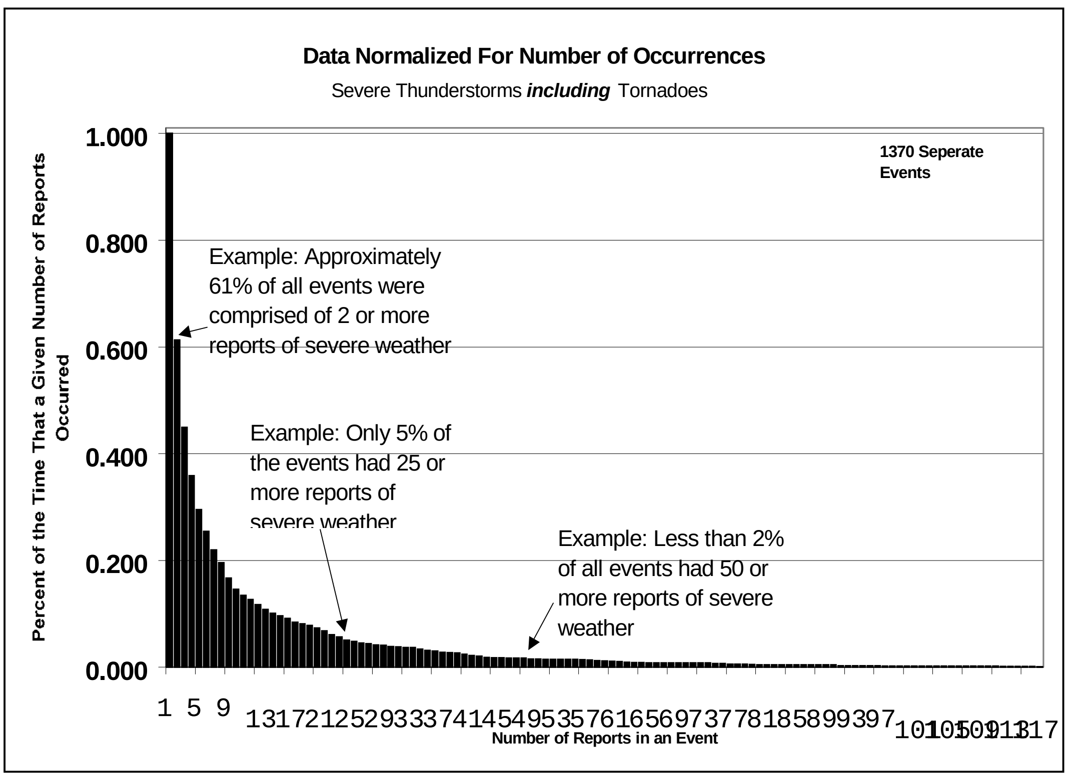

Figure 2. The frequency of severe weather events by the number of reports of severe weather associated with each event.

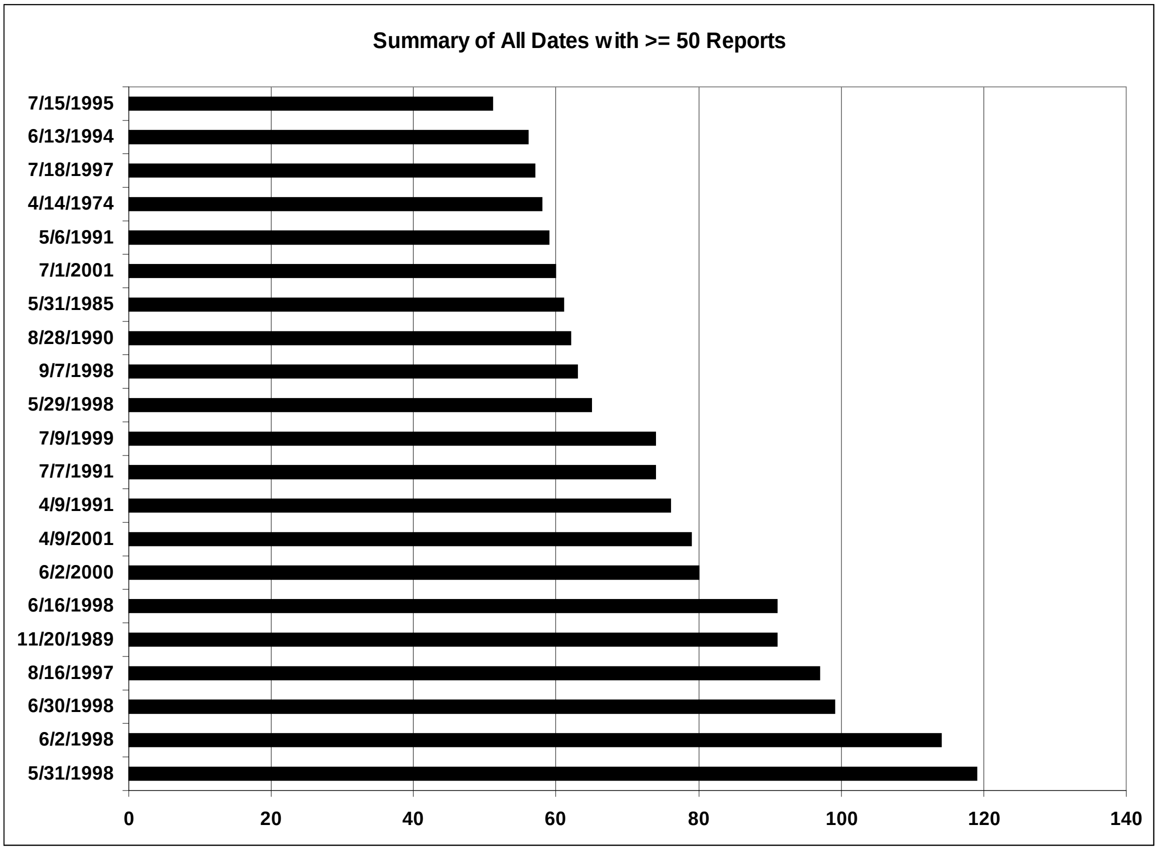

Figure 3. The dates and number of severe weather reports associated with severe weather events associated with at least 50 reports of severe weather or more.

larger events (Figure 3). These data revealed that the large tornadic event of 31 May 1985 was associated with more than 60 reports of severe weather. It is also interesting to note the number of large events in the late 1990s. These data suggest the impact of the National Weather Service modernization on the severe weather climatology over Pennsylvania.

Figure 4 shows the number of tornadoes observed in Pennsylvania by the time of day. These data suggest an afternoon maximum in tornado occurrence. In the early morning hours, tornadoes are a very rare occurrence. This suggests that issuing tornado warnings between about 12-8 AM local standard time is a very low probability forecast.

Figure 5 shows the large-scale conditions associated with the 31 May 1985 tornado episode over Pennsylvania. Other events, such as the 31 May 1998 and 2 June 1998 showed many of the same features (not shown). A common feature found in these data is an anomalous surface cyclone tracking across the Great Lakes

4. Conclusions

The data revealed the character and the climatology of severe weather over Pennsylvania. These data showed that the well-known winter minimum in severe weather with a rapid increase in severe weather events from March to June. June and July were the two most active months for both severe thunderstorms and tornadoes. Severe weather dropped off from July through December, with a hint of a secondary maximum of severe weather in November.

The majority of severe weather events in Pennsylvania are comprised of 5 or less reports of severe weather. There appear to be some events comprised of 40 or more severe reports, however, these events are not very common and do not occur with regularity. It would appear that an event of 25 more reports of severe weather represents a large severe weather event.

Strong and violent tornadoes are quite rare in Pennsylvania. These events appear to contain

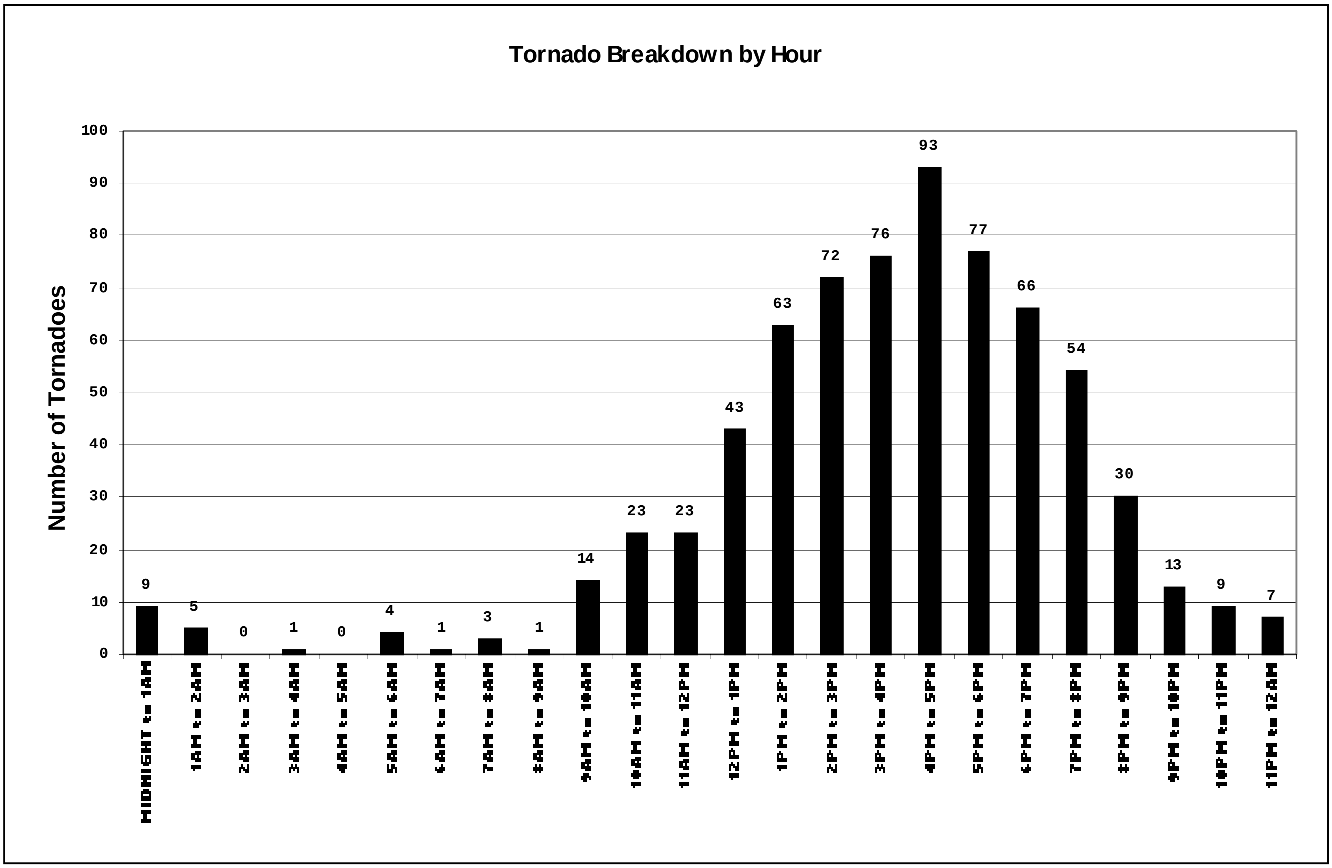

Figure 4. As in figure 1 except tornadoes by hour.

many similar characteristics, including the track of an anomalously strong surface cyclone over the Midwest and across the Great Lakes. A strong cold front typically extends to the south-southwest of this low. Ahead of the cold front there appears to be an anomalously strong low-level 850 hPa jet and a surge of moisture head of the front. Upper-level winds and heights suggest an anomalously deep upper-level trough passing to the northwest with strong west to northwest winds. Due to the presence of the relatively cool Atlantic Ocean to the east, the low-level southwesterly winds may play a critical role in keeping the low-level stable air out of the region.

Further research is required to improve the signal associated with severe convective weather events. We plan to build a database to correlate which anomalies may provide better clues to forecast widespread severe events and strong tornadic events.

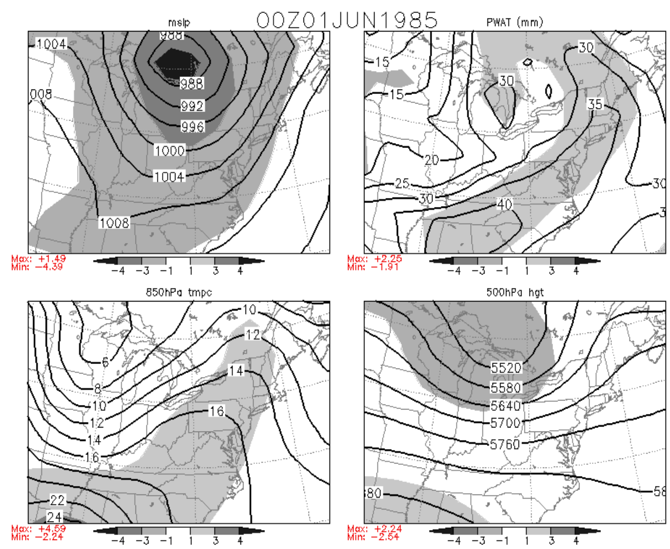

Figure 5. Plot valid 0000 UTC 01 June 1985 of MSLP (hPa), precipitable water (cm), 850 hPa temperatures (0C), and 500 hPa heights (m). Each fields departure from normal is shown in the number of standard deviations from normal (shading)

References

Available upon request.