EASTERN REGION TECHNICAL ATTACHMENT
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SEVERE THUNDERSTORM OUTBREAK 6/13/87

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Editor's Note: The severe weather checklist mentioned below may be found in Gulezian, D.P. 1980: Severe Weather Checklist Used at NWS Forecast Office, Portland, ME. Bulletin of the A.M.S., 61, pp. 1592-1599.

I. INTRODUCTION

During the afternoon and evening of 6|13|87, severe thunderstorms occurred in 9 counties of the WSFO Philadelphia forecast area. The counties where severe weather occurred were Fulton (1400 EDT) and Centre (1600 and 1610) in Harrisburg's county warning area (CWA), Clinton (1555) and Bradford (1602) in Williamsport's CWA, Burlington (1915 and 1935), Bucks (2020), and Mercer (2030-2055) in Philadelphia's CWA and Ocean (1730, 2120, and 2150) and Eastern Burlington (2112) in Atlantic City's CWA. The worst storm was a microburst in southern Mercer county which produced estimated winds of around 100 mph, golf ball size hail, and over $1 million damage.

The severe weather checklist indicated conditions were ripe for severe weather. The thunderstorm potential statement issued at 1045 AM EDT indicated that some thunderstorms could be severe with wind gusts in excess of 50 mph and moderate hail. This statement also isolated southeast Pennsylvania and southern New Jersey as the area with the greatest threat of severe weather. Zone forecasts issued at the same time contained similarly strong wording.

Let's look at the meteorological conditions that produced this severe weather outbreak.

II. SURFACE

A cold front stretched from central New England to central Michigan. It stayed north of the forecast area thru the severe weather event. A surface trough developed ahead of the front and became the main thunderstorm producer.

Surface dewpoints were in the 65-70° range ahead of the trough and 60-65° behind it. By 12Z, convection was already occurring in the middle and upper Susquehanna Valley. This indicated early morning instability over the forecast area. This line of convection dissipated as it dropped southeast through the morning. It set the stage for 2 other stronger lines of convection which began in Susquehanna Valley during the early afternoon and then moved east. Despite the convective clouds and associated cirrus blow off over the northern half of Pennsylvania, and then cirrus and haze over the southern half of the state, enough solar heating occurred so that maximum temperatures reached 84-89° across the forecast area, exceeding the convective temperature of 82°F.

III. 850 Millibars

The maximum temperature ridge (NE to SW through PA) at 12Z was west of the maximum moisture ridge (over eastern PA). The 850 mb wind at time of severe weather was about 20 kts and the 850 temperature increased from +14 to +16°C. It appeared from the 12Z 850 vorticity analysis, that weak NVA would be occurring at 850 mbs during the day. We don't have the 14/00Z analysis to confirm this. The necessary low level heating and moisture was certainly present at 850 mbs just as it was at the surface. It also appeared that we were to the left of an 850 mb jet that was running right up the east coast.

IV. 700 Millibars

Although it was wet at 700 mbs (dew point depression _5) at 12Z over the forecast area, drying was occurring above 600 mbs. This drying worked its way down to the 700 mb level during the day, as confirmed by the 14/00Z 700 mb chart. At 12Z a 700 mb no-change line did exist over western PA, and moved over the forecast area during the severe weather outbreak.

V. 500 Millibars

At 500 mbs significant cooling occurred (-2° or -3°C) over the forecast area. Atlantic City dropped from -9°C to -12°C between 13/12Z and 14/00Z. Winds were around 35 knots. The NGM indicated weak PVA moved through the forecast area during the time of severe thunderstorms. VORCON (western region vorticity - convergence program) indicated that PVA was moderate to strong at this level.

VI. 300 Millibar/200 Millibar LEVEL

12Z VORCON showed a very strong area diffluence at 300 mbs over the eastern Great Lakes into eastern Ohio. The southern part of the diffluent area more than likely passed through the forecast area during the time of severe weather. Again, we don't have the 14/00Z charts to confirm this. Southern portions of the forecast area were in the southwest quadrant of a 70 knot jet at 200 mbs. Atlantic City warmed 1 degree -37° to -36°C at 300 mbs but cooled 2 degrees -57°C to -59°C between 13/12Z and 14/00Z.

VII. SOUNDINGS

The soundings destabilized during the day with low level warming and mid and upper level cooling. Potential instability also increased as mid level drying set in, while low levels were extremely moist. The wet-bulb zero at Atlantic City dropped from 11,500 feet at 13/12Z to about 9800 feet at 14/00Z, indicating hail of 3/4 inch to golf ball size could occur. The trop dropped from around 42,500 feet at 12Z to 38,700 feet at 00Z. The equilibrium level at Atlantic City was 32,700 feet at 12Z and 42,000 feet at 00Z. Some thunderstorm tops exceeded the Trop by up to 15,000 feet and equilibrium level by up to 10,000 feet, another strong indicator for hail and severe weather. The lifted index at Atlantic City dropped from -1 to -8 between 12Z and 00Z. Pittsburgh and Buffalo 12Z hodographs showed veering of the shear vector in the lowest 6,000 and 5,000 feet respectively. The Bulk Richardson number for BUF at 12Z was 25 and at PIT was 24 with 34 at ACY (within severe weather range). At 00Z Atlantic City had veering of the shear vector up to 3000 feet. Our objective aid for computing maximum wind gusts computed 52 knots for a maximum gust based on the 12Z Atlantic City sounding.

VIII. MESOS

The southern region mesoscale program was run at 15, 17, and 19Z. It died after that, when message composition was being done on the hydrology console, where the procedure "MESOS" was running. Even though our "MESOS" only carries us into the beginning of severe weather, it does give some strong indicators that a major severe weather outbreak is about to begin. By 15Z the LI is -6 or less over the entire forecast area with an area of -8 or less over southeast Pennsylvania and southern New Jersey.

At 19Z an area of +10 moisture convergence intersected the leading edge of the surface theta W gradient just west of the central Susquehanna Valley in Pennsylvania. This is most likely the precursor to our severe thunderstorms. A 2 hour moisture convergence change (17-19Z) of +10 in the same area was also a strong indicator of what was to come, especially in light of the strong coupling between the positive moisture convergence and positive change and negative moisture convergence and negative change to its north and west. Altimeter falls of -3 or greater in the lower Susquehanna Valley were also an indicator of what was to come (coupled with a strong rise center of plus 3 over southern N.Y. State).

IX. SUMMARY

Many positive indicators came together to give our forecast area one of the biggest severe weather outbreaks in 3 years. Hopefully, by reviewing outbreaks of this type we can all learn more about what causes these, and how to forecast them prior to their occurrence.

SCIENTIFIC SERVICES DIVISION
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