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NORTHEAST MONTANA SEVERE THUNDERSTORM OUTBREAK OF JUNE 21, 1999

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Abstract

This Technical Attachment (TA) details the explosive severe thunderstorm outbreak in northeastern Montana during the late afternoon and evening hours of June 21, 1999. It describes the pre-storm initiation conditions and forecaster anticipation, or situation awareness, of the type and magnitude of the event. Forecast/warning staff decisions and resultant actions are covered just prior and during the event, including intra- and inter-office coordination. Finally, in light of recently installed AWIPS (Advanced Weather Interactive Processing System) equipment in early June of 1999, the study describes how the forecasters and HMTs adjusted to, and incorporated the new MAR equipment in the midst of an unusually challenging severe thunderstorm outbreak.

[Note: All figures appear only on the web page at http://www.wrh.noaa.gov/ under Technical Attachments.]

Introduction

The severe convection of June 21, 1999 turned out to be a particularly widespread and intense outbreak for northeast Montana. In just four hours, spanning the late afternoon and early evening, nine out of twelve counties in the Glasgow County Warning Area (CWA) were affected by severe weather including tornadoes, dime-size or larger hail, and damaging winds with gusts up to 92 mph. In our sparsely populated CWA, at least four towns (Fort Peck, Froid, Jordan, and Opheim) suffered substantial wind damage from severe thunderstorms, but no deaths and only minor injuries were reported. Total damage estimates for the area exceeded $300,000.

During this outbreak, NWSO Glasgow operations staff issued 19 warnings, of which 16 were severe thunderstorm warnings and three were tornado warnings. All 19 warnings were verified, and none of the severe episodes were missed. Overall, the average lead time on severe thunderstorm warnings was 29.8 minutes, while tornado warnings had an average lead time of 16 minutes. Later in this Technical Attachment (TA), reasons for the

successful statistical results, and more importantly, the effective communication and warning of the public, will be discussed at length.

Background

The impetus for this study is the recent focus on Situation Awareness (SA) covered in a pair of workshops sponsored by the OSF/OTB. These operationally-geared workshops are Warning Decision Making, or WDM I and II, held in Boulder, Colorado at UCAR. WDM II, in particular, emphasized the effective utility of SA in a warning, or potential warning environment at NWS field offices. When forecasters and warning meteorologists are continually aware and prepared for the variety and scope of potentially dangerous weather and its impact, they are ready to respond immediately and appropriately.

In addition, with the changeover to AWIPS, weather operations staff must adjust to the massive increase in data and analyses with limited time, coupled with the decentralized nature of the AWIPS warning environment. Thus, staff coordination and communication are essential to distill the voluminous information to a point where proper and timely decisions may be rendered both prior to, and in the midst of a significant weather event.

As described in following sections, actions taken by Glasgow forecasters in association with the June 21, 1999 severe weather outbreak were accomplished through conscientious situation awareness. Because of this mind set at NWSO Glasgow on this day, the residents of northeast Montana were well informed of the impending threat and had time to act accordingly.

Prior to the Event

As early as Sunday night (June 20), forecasters became concerned with the possibility of strong to severe convection during Monday afternoon and evening. The short-range models, especially the ETA, were forecasting a vigorous Pacific shortwave to approach eastern Montana during peak afternoon heating (Figs. 1-2). An intense, surface low-pressure system and moderate cold front were predicted to develop ahead of the wave and move into northeast Montana by late on the 21st with attendant convergence, excellent low-level moisture, surface dewpoints well into the 60s, and temperatures soaring into the 90s (Figs. 3-4).

During the predawn hours of June 21, the forecaster on duty processed N-SHARP soundings for Glasgow from the 0000 UTC 21 June 99 ETA model for 18 hr and 24 hr forecast times, i.e., 1800 UTC on the 21st (Fig. 5) and 0000 UTC on the 22nd. The dramatic parameter results included CAPE values around 3000 J/kg, Max Parcel Level of near 45K feet, LI's of close to -10, and maximum Storm Relative Helicity (SRH) of 107 m2/sec2. Based on the above forecast parameters and surface and upper-air analyses, the Storm

Prediction Center (SPC) issued the 12Z Day 1 convective outlook for June 21, covering all of northeast Montana in a Slight Risk of Severe Thunderstorms for the afternoon and evening hours.

The observed Glasgow sounding for 1200 UTC (Fig. 6) left little doubt of the potential magnitude of severe weather once the capping inversion was broken. Critical parameters from the sounding were a CAPE of 685 J/kg, LI of -4, and SRH of 65 m2/sec2. When the sounding was modified for expected afternoon conditions, the parameters closely matched the magnitude of values provided by the 0000 UTC ETA as noted in the above paragraph.

Good Situation Awareness (SA) of possible widespread severe thunderstorms prompted the day shift forecasters at NWSO Glasgow to alert the local public and emergency services personnel of the threat. They disseminated a Special Weather Statement (SPS), or Severe Weather Outlook at 1700 UTC, highlighting the potential for severe weather later that day. The senior forecaster then ordered a special 1800 UTC (Figs. 7-8) upper- air release to obtain more current data and assess upper-level trends since 1200 UTC. This sounding further solidified the decision to prepare for a significant severe outbreak event. New sounding parameters included a CAPE of 2473 J/kg, LI of -8, and SRH up to 201 m2/sec2. The cap was rapidly eroding, and the low-level shear and SRH could support tornadoes.

The forecasters informed local operations staff of the threat, as well as neighboring NWS offices in Great Falls, Billings, and Bismarck. A plan of action was initiated, ensuring that adequate warning staff would be on hand for the late afternoon and evening. Shortly after coordination was accomplished, SPC called to discuss issuance of a Severe Thunderstorm Watch for southern and southeastern Montana, including southern portions of Glasgow's CWA. Strong convection had just erupted near and to the east of Billings, with northeastward movement toward our area.

The Event

In advance of the approaching convection, surface conditions were ideal for explosive thunderstorm development over northeast Montana (Fig. 9). Temperatures were approaching 90 degrees, dewpoints were in the 60s to near 70 degrees, and a moderate north-south oriented cold front was to the immediate west of Glasgow. At 2140 UTC SPC issued the watch for southeast Montana, which included the southern counties of the Glasgow CWA. Shortly after this time, NWSO Glasgow's senior forecaster consulted with SPC to expand and upgrade the watch to a Tornado Watch for the rest of northeast Montana. The senior forecaster's reasoning was based on the low-level moisture axis in place in northeastern Montana and an AWIPS-analyzed surface low pressure moving north-northeastward from the Billings area along the cold front. Less than two hours later, when unfolding of the severe outbreak became evident (Fig. 10), SPC issued a Tornado Watch at 2347 UTC for all of northeast Montana, effective at 0030 UTC/June 22.

A cluster of strong-severe thunderstorms, racing out of Billings' CWA, reached the southern extremity of Glasgow's area just after 0000 UTC (Fig. 11). This prompted the first in a series of severe thunderstorm and tornado warnings issued for northeastern Montana counties. Thankfully, the Glasgow sounding was completed at this time, well before the widespread convection reached the site. The result was a usable sounding uncontaminated by thunderstorms (Fig. 12). Parameters corroborated earlier forecasts closely, with a CAPE of 2936 J/kg, LI of -9, and Total Totals of 59. The temperature had matched the convective temperature of 93 degrees, eliminating the cap.

The surface low that had been near Billings earlier moved up to near Glasgow by 0100 UTC on June. This new position of the low center turned out to be a critical factor in further convective intensification. By 0130 UTC, the KGGW 88-D indicated TDAs and MESOs in the thunderstorms developing in Garfield County, south of the Missouri River. Glasgow's warning staff was at a heightened awareness of the potential tornado threat from these rotating supercells. By 0200 UTC, as these supercells moved into southern portions of Phillips and Valley Counties, radar indicated strong straight-line winds. Thus, severe thunderstorm warnings were quickly issued for these areas. These warnings were later verified by reports of wind gusts from 80 to 93 mph from the public, spotters, and an NWS employee. Between 0200 and 0230 UTC (Fig. 13), numerous MESOs and TDAs were displayed over eastern Phillips and Valley Counties on several radar scans. Two or three cells in particular began to display positive indications of tornadic potential, including hook echoes. Tornado warnings were immediately disseminated for eastern Phillips and Valley Counties, including Glasgow, between 0230 and 0245 UTC. Spotter reports later confirmed a tornado near Saco, in eastern Phillips County, and two Valley County tornadoes, one just 18 miles west of Glasgow and the other at Opheim. Prior to touchdown, the Opheim tornado set off several TDA and TVS-detected alarms. Damage from the tornadoes and straight-line winds were concentrated along the path of the Valley County storms north and west of Glasgow through the community of Opheim.

Widespread severe storms continued to move northeast through the remainder of northeast Montana until 0415 UTC, when the activity exited the area into western North Dakota and southern Saskatchewan. No other tornadoes were reported, though radar indications of strong rotation were observed briefly in cells east of Glasgow.

Results

As previously listed in the Introduction section, numerous severe thunderstorm and tornado warnings were issued and subsequent severe episodes occurred during the late afternoon and evening hours (UTC) of June 21 - 22, 1999, respectively, in northeast Montana. Due in large part to the excellent situation awareness and AWIPS utilization of the NWSO Glasgow operations staff, this impressive severe weather outbreak was handled exceptionally well. Beyond receiving helpful spotter reports, weather staff on hand sought additional information by phone from spotters near threatening storms. Telling statistics included 100% verification of 19 warnings, and lead times averaging nearly 30 minutes for severe thunderstorm warnings, and 16 minutes for tornado warnings.

Warnings did reach the intended audience, the general public of northeast Montana, emergency services, and other vitally interested authorities. One glaring exception, however, was the community of Opheim, which was struck by an F1 tornado. This location, being over 50 miles from the nearest NOAA Weather Radio transmitter, was out of range of NWR coverage. As a result, authorities and residents of Opheim did not receive the tornado warning in time. This communications breakdown will be rectified for future warning situations for northern Valley County. Local Glasgow dispatch will call a contact point in Opheim from now on to relay warnings for this remote site.

Conclusions

Proper and diligent analysis/diagnosis of potential severe weather events, heightened anticipation of the expected threat, and decisive teamwork actions are the keys to effective Situation Awareness for any field office in the NWS. This particular severe event demonstrates a pertinent example of this essential concept. If any of the above key items are neglected or downplayed, minor to disastrous consequences could result. This would directly impair the ability and most importantly, the responsibility to protect and ameliorate life, property, and the economic well-being of the citizens the NWS serve. In any potential severe weather event of this magnitude, it is critical that the field offices affected would be aware of, and in agreement on the threat well ahead of expected onset, preferably 12 to 24 hours in advance. Granted, this goal will not always or not even usually be possible in some cases, due to the uncertainty inherent in the science of meteorology, such as lack of data, errors incorporated in the models, and the overlooking of important but sometimes obscure clues. But, to the extent that forecasters are able to forecast and warn with this uncertainty, this awareness and pursuit of it should be practiced and encouraged on a routine basis to reduce, if not avoid unpleasant surprises in the realm of severe weather.

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