Effective Use of Various Communication Methods during a Severe Convective Outbreak

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Abstract

On the afternoon and evening of 15 May 2003, 26 tornadoes occurred across the Amarillo (AMA) National Weather Service Forecast Office (WFO) County Warning Area (CWA), establishing a one-day tornado record for the 23 county, CWA. The great majority of the AMA WFO consists of sparsely populated, rural areas with limited NOAA Weather Radio coverage and few storm spotters. In the days leading up to the afternoon of 15 May 2003, select forecast products were written containing straightforward language that targeted local media and emergency management communities. Additionally, on the day of the event a conference call was established with local media and emergency managers in order to further ensure these groups were aware of the impending severe weather threats. The media and emergency management communities then highlighted the hazards for the public in their respective products and communications both prior to and during the severe weather episode. To overcome the issue of limited storm spotter coverage and to aid the warning decision process, the AMA WFO contacted a portion of the storm chase community prior to the severe weather to solicit valuable field observations via telephone and email. Storm chasers provided 65% (17 of 26) of the tornado reports. No deaths or serious injuries occurred from the event. The statistic is chiefly attributed to both the local media and emergency management. Through their efforts, public awareness of the severe weather threat was increased prior to and during the event.

This paper describes the measures and actions, some of them uncommon, taken by AMA WFO, which contributed to the successful outcome of the warning process during this severe weather episode.

1. Introduction

On the afternoon and evening of 15 May 2003 an outbreak of tornadoes occurred across a portion of the southern and central plains of the United States. Within the Amarillo (AMA) National Weather Service Forecast Office (WFO) County Warning Area (CWA), the day was marked by a record 26 tornadoes over a span of eight hours. The AMA CWA is comprised of 23 counties located in the Texas and Oklahoma Panhandles covering 26,316 square miles (Fig. 1). The previous record number of tornadoes for one day was 23, on 8 June 1995[1]. On 15 May 2003, several of the tornadoes were large, long track tornadoes (e.g., up to one kilometer wide with a 16 kilometer path length). However, the vast majority of the tornadoes were not significant (failed to produce $\geq$ F2 damage, after Grazulis 1993). The strongest tornado received an F2 rating (*Storm Data* 2003). There were no reports of deaths or serious injuries from the tornadoes even though several of the tornadoes produced damage in populated areas. In addition to the tornadoes, 7 cm diameter hail and 31 (32) m s^{-1} downdraft (inflow) winds occurred. Some inflow winds produced F1 damage on the Fujita-scale rating (Fujita 1971). Following the event, it was found that numerous homeowners left their residences for secure shelter, in some cases a full hour prior to a tornado having an impact on their homes.

Traditionally, WFOs have utilized a number of resources in order to disseminate their forecast and warning products to the public in a timely manner. These include NOAAport[2], NOAA Weather Radio and direct communications with mass media and emergency managers. Furthermore, during episodes of severe weather, storm spotters have proven to be a valuable

1 On 8 June 1995 the AMA CWA was comprised of 33 counties covering 42,068 square miles.

2 The NOAAPORT broadcast system provides a one-way broadcast communication of NOAA environmental data and information in near-real time to NOAA and external users.

resource for real-time reports and warning verification. These mediums have worked well, particularly for field offices that have large NOAA Weather Radio coverage and a large population within their respective CWA. However, as of 15 May 2003, the AMA CWA had only a limited NOAA Weather Radio coverage footprint (Fig. 1). The population distribution within the AMA CWA is vastly rural, with low population densities outside the greater Amarillo metropolitan area. Thus, the greater part of available storm spotters were limited to the Amarillo area.

In order to overcome those limitations in the dissemination of severe weather information for the 15 May 2003 tornado outbreak, the AMA WFO utilized local media and emergency managers to help "get the word out" concerning the day's threat and watch/warning information. Previous studies have demonstrated the primary source by which the public obtains NWS warning information is through television media (Biddle 1994; Legates and Biddle 1999). In one study 9 of 10 residents in the path of a tornado used television at some point in the warning phase with 61% using television as the initial warning notification or primary source (Biddle 2000). Coordination between the AMA WFO, the surrounding WFOs, and the Storm Prediction Center (SPC) allowed for timely and properly disseminated forecast products that contained candid wording. Direct contact was established with county emergency managers and television meteorologists a few hours prior to the onset of the event. To aid in the warning decision process, the AMA WFO successfully requested real-time storm observations, by telephone and email, from some of the storm chase community. This was the first time email was utilized at the AMA WFO as a source for real-time ground truth information during severe weather operations. The lack of deaths and injuries was chiefly attributed to both the local media and emergency

management, who helped convey to the public forecast information and warnings, and successfully heightened public awareness prior to and during the event.

Section 2 provides examples of text products, personal communication, and post-event information conducted by the AMA WFO. Conclusions and recommendations are contained in Section 3.

2. Outreach Evolution

a. Text products

The first mention of the severe weather potential for 15 May 2003 occurred in the SPC Day-3 convective outlook and in the AMA WFO's area forecast discussion (AFD) and hazardous weather outlook products three days prior to the beginning of the severe weather. As the details of the event became better defined and forecaster confidence increased with each successive day, external coordination increased between the AMA WFO with surrounding WFOs and the SPC. The wording in the AFDs became straightforward regarding the potential threat:

"THE EVENT COULD POSE THE LARGEST THREAT FOR SVR STORMS IN TERMS OF AREAL COVERAGE THUS FAR IN THE SEASON FOR OUR CWA."

Concurrently, the WFO hazardous weather outlooks continually highlighted the severe threat:

"...**STRONG TO SEVERE THUNDERSTORM DEVELOPMENT WILL BE POSSIBLE ON THURSDAY AND THURSDAY NIGHT ACROSS THE OKLAHOMA AND TEXAS PANHANDLES**."

The local television, radio, and newspaper media further relayed this information to the public in their respective broadcasts and products.

On the morning of 15 May 2003 the SPC issued a high risk for severe storms that encompassed most of the Texas Panhandle. To further convey to the public the SPC high risk

and their public severe weather outlook, the AMA WFO issued a special weather statement. While the issuance of a special weather statement in these circumstances is not unusual in itself, the issuance of this statement and the strong wording contained within it helped to accentuate the threat particularly to those in the media and emergency management community.

"...AN OUTBREAK OF SEVERE THUNDERSTORMS AND TORNADOES IS EXPECTED THIS AFTERNOON AND EVENING ACROSS THE OKLAHOMA AND TEXAS PANHANDLES... ALL PEOPLE IN THE OKLAHOMA AND TEXAS PANHANDLES ARE STRONGLY ENCOURAGED TO REVIEW THEIR SEVERE WEATHER SAFETY RULES AND HAVE A PLAN OF ACTION IN PLACE AS A MEANS TO PREPARE FOR THIS POTENTIAL UPCOMING AND DANGEROUS SEVERE WEATHER EVENT."

A special AFD was issued at 1618 UTC specifically focused on the severe weather potential. The intent of the discussion was to inform the media and emergency management of the latest meteorological conditions. The discussion outlined how the event was thought to be unfolding, what type of severe threats to expect, and how these threats would change over time.

"CURRENT SPC HIGH RISK ACROSS THE CWA APPEARS ON TRACK. UPPER-LEVEL SHORT-WAVE TROUGH RAPIDLY APPROACHING OUT OF NEW MEXICO. EXPECT THE CIRRUS DECK TO PERSIST THROUGH THE MID AFTERNOON INHIBITING CONVECTION INITIATION. 12Z SNDGS INDICATE RELATIVELY SHALLOW MOISTURE BUT WE FEEL MOISTURE WILL INCREASE ONCE ISALLOBARIC FLOW DEVELOPS IN RESPONSE TO RAPID CYCLOGENESIS ALONG THE SFC BAROCLINIC ZONE IN EASTERN NEW MEXICO. EXPECTING RAPID INITIATION ALONG THE WESTERN EDGE OF CIRRUS SHIELD AFTER 20Z TODAY. SOME QUESTION REMAINS AS TO THE NORTHWARD EXTENT OF THE WARM FRONT AND MODE OF CONVECTION. ATTM BASED ON REGIONAL PROFILERS...RAOBS...AND MODIFIED HODOGRAPHS...THE SOUTHERN/WESTERN PORTION OF THE CWA APPEARS MOST FAVORED FOR A DISCRETE SUPERCELL WINDOW...CONVECTIVE CLUSTERS WITH EMBEDDED SUPERCELLS FURTHER NORTH. THE ACTIVITY IS EXPECTED TO MOVE FROM WEST TO EAST WITH CELL MOTION TO THE NORTHEAST AT 25 TO 35 MPH. ZONES HAVE BEEN UPDATED TO REFLECT THE SVR THREAT."

As mentioned in the AFD, the zone forecast text product issued at 1539 UTC highlighted the severe threat by including the following wording in all forecast zones:

"...SHOWERS AND THUNDERSTORMS. SOME POSSIBLY SEVERE PRODUCING LARGE HAIL AND TORNADOES."

The afternoon AFD issued at 1829 UTC continued to outline the anticipated evolution of

severe convection with the intention to keep the local media and emergency managers informed on the day's progression.

"SEVERE WEATHER IS EXPECTED TO DEVELOP BY MID AFTERNOON ACROSS THE WESTERN PORTION OF THE CWA. SUPERCELLS ARE LIKELY WITH SOME POSSIBLY TORNADIC. THE ACTIVITY SHOULD FIRST DEVELOP BY 20Z IN THE NORTHWEST CORNER OF THE CWA AND EXPAND SOUTHWARD THROUGH THE AFTERNOON ALONG/NEAR THE NM/TX BORDER. BASED ON THE SFC EVOLUTION...PROFILER...VAD...SAT...AND SHORT-TERM GUIDANCE FEEL THE LARGER WINDOW FOR DISCRETE SUPERCELL ACTIVITY WILL BE FAVORED ACROSS THE SOUTHERN HALF OF THE CWA. EXPECTING SUPERCELLS THAT DO DEVELOP ACROSS THE NORTHWEST PORTION OF THE CWA TO EVOLVE INTO LINE SEGMENTS/SQUALL BY LATE THIS AFTERNOON/EVENING. THE ACTIVITY WILL MOVE FROM WEST TO EAST. THE LOCATION OF THE WARM FRONT WILL HAVE AN IMPACT ON THE TORNADO PROBABILITIES IN OUR CWA...GREATEST THREAT APPEARS ALONG AND NORTH OF THE WARM FRONT. THE SVR THREAT WILL WANE LATER TONIGHT WITH SHOWERS CONTINUING THROUGH THE FIRST HALF OF TOMORROW...ENDING WEST TO EAST."

Shortly after 2000 UTC, the first tornadic supercells developed in the northwest portion of the AMA CWA. Aside from the tornado warnings and severe weather statements associated directly with each storm, the short-term forecast product further emphasized the tornado threat. Extreme care was given to wording so as not to conflict with any of several current warnings (e.g., storm location and motion). To ensure all users of the short-term forecast product received the same information either through NOAA Weather Radio, NOAAport, or the media, the product was non-segmented (e.g., all counties within the AMA CWA were included in the product issuance). Short-term forecasts were updated every 30 to 60 min throughout the event underscoring the importance of the situation.

"AT 545 PM TORNADIC SUPERCELL THUNDERSTORMS WERE LOCATED ACROSS THE WESTERN PORTION OF THE TEXAS AND OKLAHOMA PANHANDLES IN CIMMARON...AND DALLAM COUNTIES. SEVERAL LARGE TORNADOS HAVE BEEN CONFIRMED IN NORTHEAST DALLAM COUNTY. THE STORMS WERE MOVING NORTH NORTHEAST AT 25 MPH. ADDITIONALLY... NEW STORMS WERE BEGINNING TO DEVELOP AHEAD OF THE DRYLINE IN RANDALL AND SOUTHERN ARMSTRONG COUNTIES. THESE STORMS WERE MOVING NORTHEAST AT 40 MPH.

SURFACE AND SATELLITE OBSERVATIONS INDICATE A WARM FRONT EXTENDED ACROSS THE TEXAS PANHANDLE FROM NEAR DALHART...TO NEAR AMARILLO ...TO NEAR CHILDRESS. THE DRYLINE WAS RAPIDLY MIXING EAST INTO THE WESTERN PORTION OF THE TEXAS PANHANDLE SOUTH OF THE WARM FRONT. SURFACE WINDS CONTINUE TO INCREASE IN

SPEED ALONG AND NORTH OF THE WARM FRONT ENHANCING THE SHEAR PROFILES. THE IMPROVING SHEAR PROFILES COMBINED WITH THE ATMOSPHERIC INSTABILITY WILL ENHANCE THE TORNADO THREAT OVER THE NEXT SEVERAL HOURS ESPECIALLY EAST OF HIGHWAY 287 AND INTERSTATE 27.

THROUGH 8 PM ADDITIONAL SUPERCELL THUNDERSTORMS ARE ANTICIPATED TO DEVELOP SOUTHWARD ALONG THE WARM FRONT AND DRYLINE. THE STORMS WILL MOVE NORTHEAST AT 30 TO 35 MPH. VERY LARGE HAIL AND TORNADOES ARE POSSIBLE WITH ANY SUPERCELLS THAT DEVELOP."

b. Personal communication

On the day of the severe weather, AMA WFO conducted a conference call with emergency managers and local media. The decision to hold a conference call was based on two factors: to give all decision makers the same information at the same time, and to provide a forum for questions and answers. In addition, since NOAA Weather Radio coverage in the Amarillo CWA was limited, the conference call was deemed to be the best way to reach as many decision makers as possible within a short amount of time.

The conference call was scheduled for 1845 UTC. This was more than an hour before the initiation of the expected deep moist convection, but long enough after the issuance of the hazardous weather outlooks, AFDs, and special weather statements to allow emergency management officials and media time to read those products and to develop questions for the call. Approximately 20 members from the emergency management and media communities participated in the conference, which lasted 15 minutes. The call focused on two items: the meteorology behind the anticipated outbreak, and the expected timing and magnitude of the event. Extra emphasis was placed on the AMA WFO's confidence level that tornadoes would be the primary severe weather threat.

The response to the conference call was enthusiastic. Emergency managers expressed that

they would implement their local emergency plans of action by the end of the day. One emergency manager stated, "I learned more from that call than I learned all day." Another emergency manager conveyed that he accelerated maintenance plans for his town's sirens after the call. One Amarillo television station sent a news crew to the AMA WFO to record office operations during the severe weather outbreak and also conducted live reports from the WFO during the early evening news. Furthermore, several live radio interviews were conducted early in the event with a radio station in Perryton, Texas. The radio interviews stressed the timing and magnitude of the outbreak, and urged listeners to be aware of the rapidly changing conditions. Such conference calls are now routine for the AMA WFO if a significant weather episode is expected.

To address the lack of spotter coverage across the AMA CWA, an effort was made to contact the storm chase community. It was assumed that because the event was primarily focused across the Texas and Oklahoma Panhandles, a large number of storm chasers would be present in the AMA CWA. On 14 May 2003 a request was sent to more than 150 experienced storm chasers via email to a single server to solicit real-time reports. Contact information was provided through email addresses and pertinent AMA WFO phone numbers in order for their reports to reach the forecasters and staff directly. On the morning of 15 May 2003 a second email was sent to the server providing one forecaster's personal cell phone number as a means to avoid a chaser's report not reaching the office due to the very heavy volume of phone calls expected on the AMA WFO phone lines.

The effort to contact the storm chase community proved very worthwhile. Numerous reports were called or emailed in real-time to the AMA WFO office. In most cases, the storm chasers

were the only source for ground truth information, thereby greatly aiding the warning process. There were several instances where their information prompted the issuance of a warning or conversely, prevented the issuance of a warning. Furthermore, their information provided specifics that otherwise would not have been available allowing more detailed statements and short-term forecasts to be produced (i.e., tornado motion, size, damage, etc.). Additionally, reliably calibrated wind, temperature and moisture data were obtained in near real-time from several chasers. The data provided forecasters with in situ near storm environmental observations at the chasers' locations. A plethora of storm reports containing detailed location information and digital pictures as truth, were emailed to the AMA WFO over the 12 hours following the severe weather event. Of interest, 65% (17 of 26) of the tornado reports received by the AMA WFO were provided by the storm chase community; local storm spotters, law enforcement, media and emergency mangers accounted for the remaining 35%. This post-event information was utilized in warning verification and the damage surveys. Such broad and effective cooperation and direct communication with trusted members of the storm chasing community was largely unprecedented and proved greatly beneficial to both warning and verification operations.

A significant contributing factor in the success of the overall warning process was the coordination with the SPC and with neighboring WFOs preceding the 15 May 2003 event. Several phone calls took place between the various parties concerning the meteorology of the event. The purpose was to ensure all offices affected by the severe weather would have a consistent philosophy in conveying the threats to the public. Furthermore, coordination between offices assisted in timely updating of AMA WFO forecast products with SPC guidance and

watch information during the event (e.g., mesoscale discussions, watch issuances and clearances, etc.). Coordination also took place with the surrounding WFOs when severe convection was about to leave the AMA WFO CWA and move into adjacent WFO CWAs. The coordination allowed for seamless and consistent warnings as storms crossed CWA boundaries.

c. Post event

Immediately following the tornado outbreak damage surveys were conducted. With each onsite survey, all persons encountered (~ 40 people) were informally asked if they knew a storm and/or tornado was coming. Everyone who was asked stated they were aware of the threat and/or warning. Several homeowners specifically stated they had enough advanced warning to abandon their mobile homes to seek sturdier shelter. In some instances, homeowners received more than one full hour of warning lead time prior to the tornado striking their residence. It was also learned by the survey teams that the main sources of warning information the residence used was the television and/or public radio, consistent with that found by previous studies (e.g., Biddle 1994, 2000; Legates and Biddle 1999).

3. Conclusions and Recommendations

An outbreak of tornadoes occurred across the southern high plains on the afternoon and evening of 15 May 2003, establishing a one-day record of 26 tornadoes in the AMA CWA. Remarkably no deaths or serious injuries resulted. The event was unprecedented not only for the record number of tornadoes that occurred, but also the process by which the AMA WFO conveyed their forecast and warning information to the public. Moreover, the method used by

the office to obtain real-time warning verification was unique. The AMA CWA contains a rural population with both limited NOAA Weather Radio coverage and highly uneven distribution of storm spotters. To overcome these challenges, the AMA WFO utilized the local media, emergency management, and storm chaser communities.

Three days prior to the onset of the severe weather, the AMA WFO began including the possibility of a severe weather outbreak in forecast products, in tandem with SPC outlooks. Over the three days leading to the severe outbreak forecaster confidence in the potential threat increased. Concise, straightforward language was used in the AFDs in order to convey to the end user, primarily the media, forecaster confidence and the magnitude of the event. The local media effectively communicated this information to a large portion of the population.

In addition to the AMA WFO text products, on the day of the event a conference call was conducted with emergency managers and local media. The call served as a catalyst for reaching as many individuals within potentially threatened communities as possible in the shortest amount of time. The feedback received after the severe weather episode from the emergency management and media was very positive. Such conference calls are now routine for the AMA WFO whenever a significant weather event is expected.

Aside from the tornado warnings and severe weather statements issued, the short-term forecast product was heavily utilized and updated frequently. The forecasts were non-segmented and updated frequently to ensure all users of the product received the same information. The product was updated frequently. Feedback received from the media and public over the days following the severe weather was very supportive and highly positive concerning the non-segmentation of the short-term forecast.

To aid the warning decision process, the AMA WFO contacted the storm chase community prior to the event in order to gain further, valuable, real-time information and verification via telephone and email. Their information, in combination with local spotters, law enforcement, media, and emergency managers aided the warning decision and verification processes, and helped in determining damage survey locations.

No deaths or injuries were reported with this severe weather outbreak. Direct communications between the AMA NWS and the local media and emergency management communities ensured that all parties were well aware of the significant threats posed during the event. The local media and emergency management communities effectively conveyed these threats to the general public and that likely played a role in the lack of injuries and deaths associated with this event. In the case of 15 May 2003, the warning process worked well. The expected threats were communicated clearly to emergency management and the media. These users were then able to disseminate this same information to the public, helping to enhance awareness of the developing severe weather situation.

The AMA WFO has exercised the procedures described in this article with similar success for a number of severe weather events since 15 May 2003. Based on the positive results above, we offer the following recommendations.

1) Straightforward wording be used in all text products for significant weather episodes in order to convey clear and concise information to all users (e.g., AFDs, zone forecasts, short-term forecasts, etc.).
2) Short-term forecasts should be issued as a non-segmented product to ensure all users within a WFO CWA receive the same, potentially life saving information.

3) WFOs whose jurisdictions contain rural gaps in NOAA Weather Radio coverage utilize all available communication resources to emphasize expected significant severe weather events. Most people learn of weather threats through television and radio; thus, in addition to traditional product dissemination, direct two-way communication like conference calls with local media and emergency management can more effectively promote public awareness of potential and ongoing severe weather threats.

4) WFOs should take advantage of all resources and technologies to aid in real-time ground truth information and warning verification. The pro-active use of email and voice communications between WFOs and the storm chase community has proven to be one such resource. As such technological capabilities become more common and inexpensive, other potentially beneficial methods of field communication from both spotters and chasers may include cellular phone transmission of real-time storm photographs to the WFO, and the display of observational data uploaded from instrumented vehicles to web sites.

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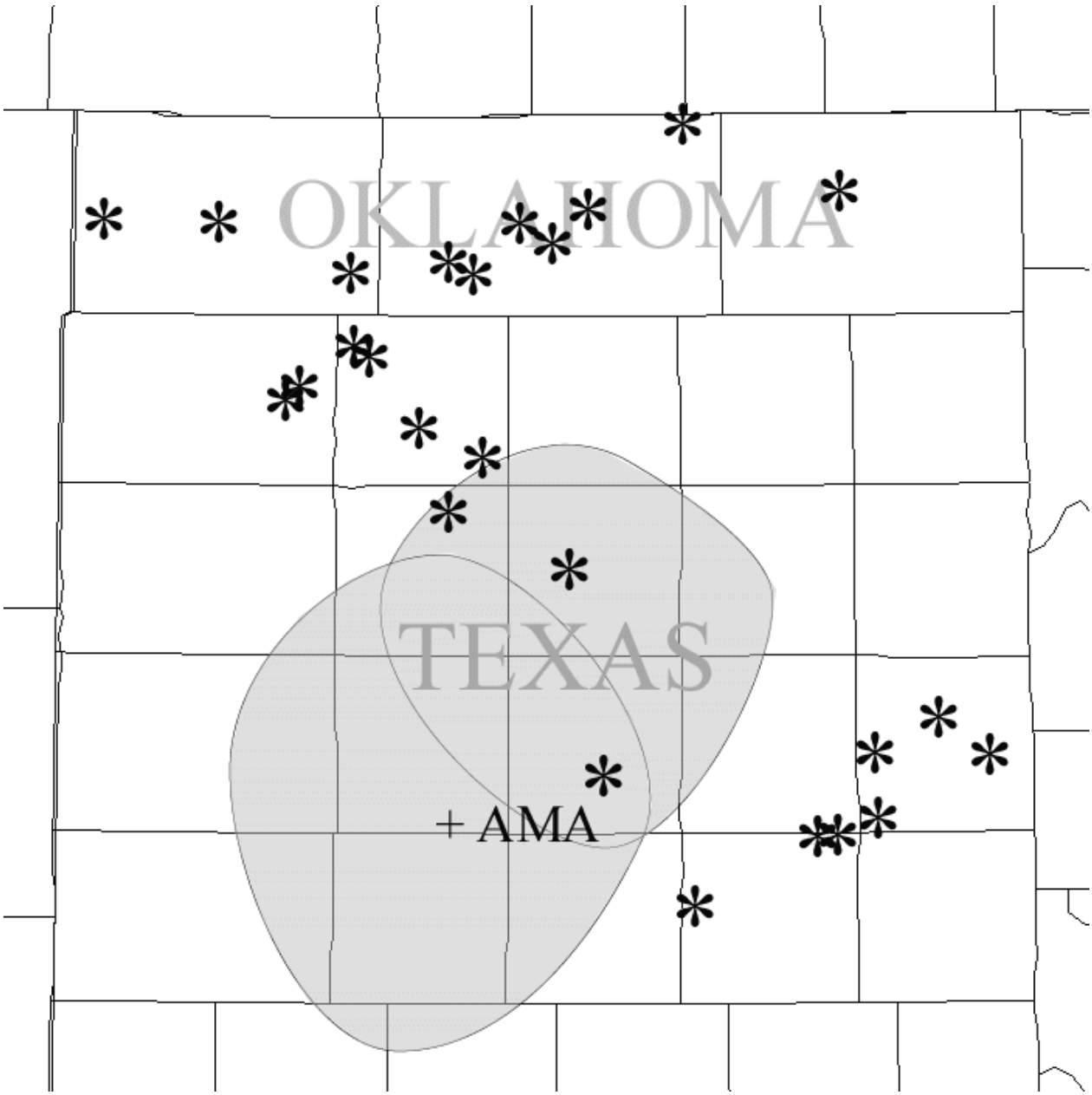

Fig 1. Locations where tornadoes first developed (*) within the Amarillo National Weather Service County Warning Area, 15 May 2003. The shaded region represents the area covered by NOAA Weather Radio. AMA denotes the location of the City of Amarillo.