16B.6 EMERGING TECHNOLOGIES IN THE FIELD IN SUPPORT OF OPERATIONS AND RESEARCH

Scott F. Blair*[1], Albert E. Pietrycha[2], Tyler J. Allison[3], Derek R. Deroche[4], Robert V. Fritchie[5]

[1]NOAA/NWS, Topeka, Kansas; [2]NOAA/NWS, Goodland, Kansas; [3]Allison House LLC, Wheaten, Illinois; [4]NOAA/NWS, Pleasant Hill, Missouri; [5]Private Meteorologist, Norman, Oklahoma

1. INTRODUCTION

Over the past half-century, mobile storm observers in the field helped revolutionize our understanding of severe storm behavior and characteristics (Doswell 2007). This was at least partially accomplished through the use of visual observations and new innovative technologies. Severe weather reports from researchers and storm hobbyists, in addition to trained SKYWARN volunteers, have long provided a significant enhancement to the warning decision process made by local National Weather Service (NWS) forecast offices.

Advances in technology over the past decade, specifically the widespread availability of low-cost, high speed internet via cell phone and broadband cards, allow storm observers an unprecedented opportunity to support both the operational and research communities with real-time information. This is especially evident in rural areas common to the American Great Plains, where very low population densities tend to limit real-time information. This paper examines three prominent emerging technologies: the Spotter Network, the Mobile Rapid Environmental Sampling System, and Live Chase Cams. These tools provide real-time applications for severe weather reporting, dissemination of data collected in situ, field coordination, mesoanalysis, warning decision making, and quicker dissemination of relevant information to the public. A vision of the development and integration of these technologies is described and discussed.

The paper will focus on technologies for individuals with interests in severe weather reporting, mobile weather observations, and streaming video. Specific equipment and uses may vary from person to person, although the overall applications described are largely universal.

2. EQUIPMENT

A mobile storm observer's equipment varies based on each individual's needs, financial ability, and purpose. A generalized outline of equipment and flow of information is provided in Fig. 1. The backbone of most field applications begins with a laptop computer, which has become relatively universal among high-tech storm observers. A global positioning system (GPS) has become standard for improved road navigation while in the field. GPS data is also necessary to compute the true wind speed and direction on mobile wind applications by utilizing simple vector calculations.

Figure 1: Outline of equipment and accessories utilized by some storm observers providing real-time data to field coordinators and operational meteorologists.

Internet access is frequently obtained in the field by using a cell phone as a modem for a laptop or PDA. An internet connection can be created through directly connecting the cell

* *Corresponding author address:* Scott Blair, NOAA/National Weather Service, 1116 NE Strait Ave, Topeka, KS 66616; E-mail: scott.blair@noaa.gov

phone by cable to the laptop, Bluetooth tethering, broadband wireless cards, or a satellite internet provider. Regardless of the method to acquire internet access, the mobile connection serves as the framework to collect and disseminate information in real-time applications.

3. TECHNOLOGIES

3.1 *Spotter Network*

The Spotter Network (SN) was created by AllisonHouse LLC and introduced to the public in early 2006. SN brings storm spotters, storm chasers, coordinators, and public servants together in a seamless network of information. The SN provides highly accurate position data of storm observers for coordination and reporting purposes and delivers 'ground truth' information to public servants engaged in the protection of life and property. The network is designed to improve the flow of real-time information without taxing human resources; both in the field, and in offices where meteorologists utilize this information.

As discussed by Pietrycha and Fox (2006), the mobile spotter/chaser contingent have proven to be a fantastic resource for real-time severe reporting, and yet, are often underutilized due to the lack of an effective communication bridge between the mobile storm observer and the NWS. This is particularly profound in NWS county warning areas containing low population densities. The SN helps greatly to fill the communication gap and utilizes the NWS eSpotter program, at no cost to the SN participant or the NWS.

Table 1: SN Accepted Reporting Criteria

• Tornado, Wall Cloud, Funnel Events
• Wind Speeds and/or Gusts > 50 mph
• All Hail Events
• All Hydro Events
• All Winter Events
• All Tropical Events
• All Notable Damage

The SN allows a storm observer to report several types of hazardous weather information through a SN graphical user interface on a personal computer (Table 1). The report can be received through eSpotter at the local NWS office within 45 s of being sent. SN participant locations and reports can be monitored through the SN website and several software clients including GRLevelX and Google Earth (Fig. 2). NWS personnel can monitor SN participant locations and query them through the supplied contact information to assist in the warning decision process. Additionally, field coordinators responsible for research teams can utilize SN to monitor the location of pertinent vehicles relative to the investigated feature and quickly report observed hazardous weather into the NWS via SN.

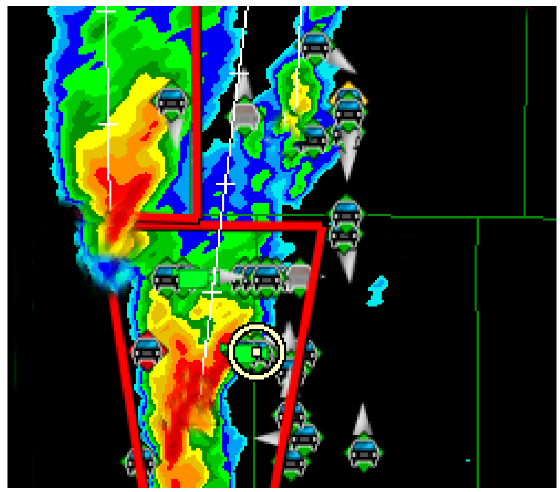

Figure 2: Example of SN as a placefile with GRLevelX software on 22 May 2008. A mobile storm observer is depicted by the diamond-shaped vehicle icon. The direction of movement of the SN participant is denoted by an arrow. Observers with live chase cams are shown as green camera icons.

The SN has provided one of the first opportunities to accurately quantify severe weather reports, as all reports are tracked and archived, including the reporting party. At the time of this writing, there were approximately 3,100 participants in the SN. From 1 January 2007 through 1 October 2008, more than 1,800 reports have been sent through SN (Fig. 3). Nearly 700 of these reports have been for severe criteria (tornado, ¾ inch hail, 58 mph wind) and were ready for Local Storm Report (LSR) issuance by the NWS. An additional 753 reports were for supplemental non-severe information (wall cloud, funnel cloud, outflow-dominant state). Approximately 350 reports were also sent for winter weather, flash flooding, and excessive rainfall reports.

A distribution of normalized SN reports by month shows a peak in May and June (Fig. 4). This is traditionally the peak period of mobile storm observers collocated within a high frequency of severe weather occurrence across the central contiguous United States (CONUS). A distribution of SN severe reports differentiated by tornado, hail, and wind shows a relatively similar breakdown by year and event type (Fig. 5).

The central CONUS contains an overwhelming number of SN reports as shown in Fig. 6a-b. Large numbers of mobile storm observers are frequently found across the central CONUS. This is extremely valuable to the warning decision process where real-time information can be obtained in rural areas.

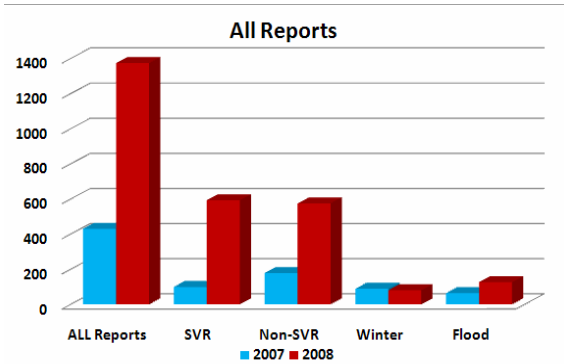

Figure 3: Distribution of all SN reports during 2007 (blue) and 2008 (red) through 1 October 2008.

3.2 *Mobile Rapid Environmental Sampling System*

The Mobile Rapid Environmental Sampling System (MRESS) was introduced in early 2008 as a means to collect, distribute, and archive mobile weather observations in real-time. The system envisions incorporating governmental and university research groups, private individuals, public servants, and others that utilize mobile scientific-grade instrumentation similar to mobile mesonet (MM) standards (Straka et al. 1996). These data are distributed in real-time through one location to ultimately support operational meteorologists in mesoscale analysis and the warning decision process.

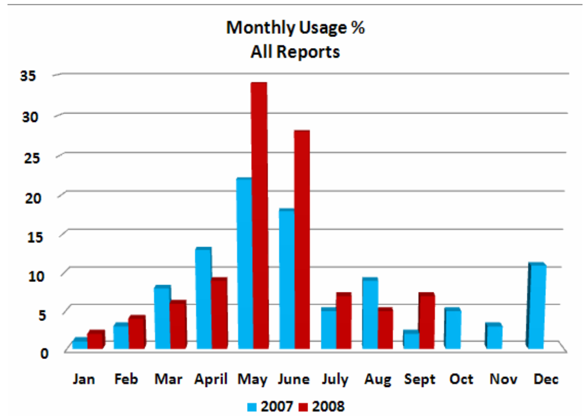

Figure 4: Normalized distribution of all SN reports by month during 2007 (blue) and 2008 (red) through 1 October 2008.

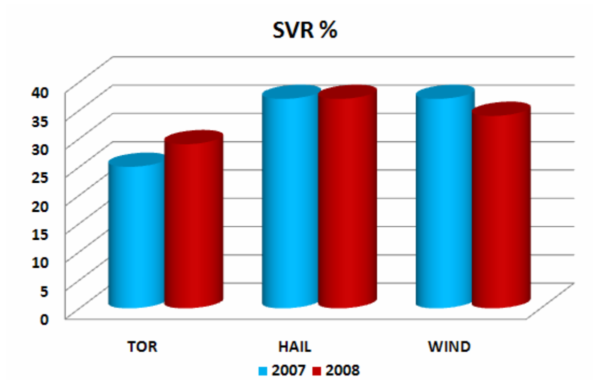

Figure 5: Distribution of severe SN reports during 2007 (blue) and 2008 (red) through 1 October 2008.

A MRESS participant has some or all of the basic surface observation instruments with scientific-grade quality. This translates to a high level of confidence in data quality for operational meteorologists monitoring and incorporating these observations into decisions. Observations from the MM vehicle are processed and transferred through the internet via cell phone connection to a central data repository server. A graphical MRESS outline is provided in Fig. 7. Data are available immediately from the MRESS website or supplemental placefiles viewable in software applications such as GRLevelX. The placefile retains a 20 minute trail of observations and eliminates clutter as observations appear/disappear depending on the desired domain and resolution of the user. Archived 1-minute observations can be viewed

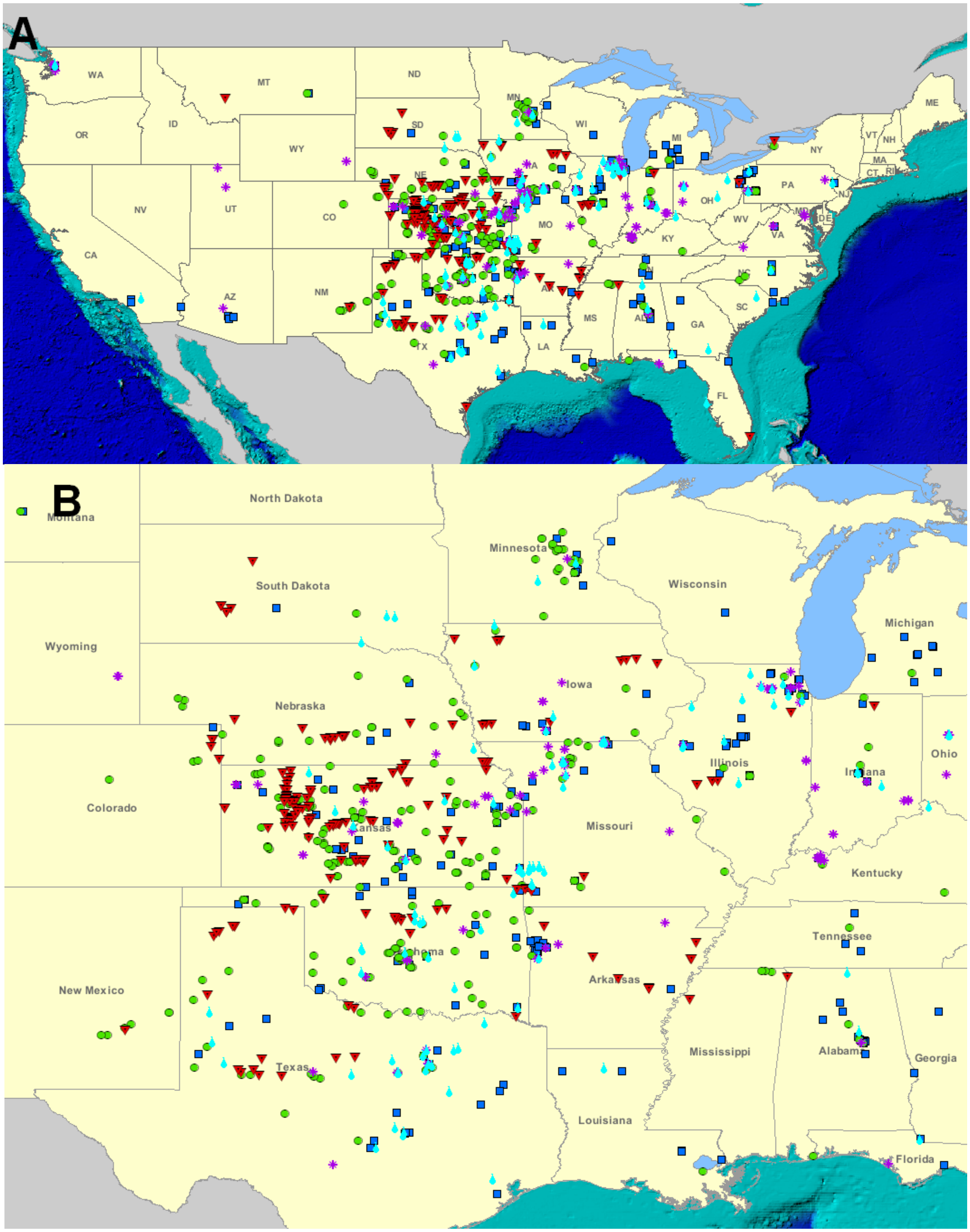

Figure 6: Distribution of SN reports across the (a) CONUS and (b) central CONUS during 2007 and 2008 through 1 October 2008. Reported tornadoes (red triangle), hail ≥ 0.75 in (green circle), wind speeds ≥ 58 mph (dark blue square), flooding (teal water drop), and winter storms (purple asterisk) are shown.

in graphical format or in supplemental placefiles through the MRESS repository server where users can request specific days and times of data.

A single MM based in Norman, Oklahoma tested the MRESS system during the spring months of 2008 with much success (Fig. 8). These data were monitored in real-time by several NWS weather forecast offices during convective warning operations. Although MRESS began with a single unit, the system is designed to support thousands of mobile observing systems. With a unique extensible communication system and data storage design, future expansion of the MRESS system should require minimal effort. The largest challenge to expand the numbers of vehicles housing mobile weather observations is the financial burden of research-grade instrumentation. It is speculated the relatively expensive costs have partially contributed in low numbers of private individuals involved in MRESS thus far. The system provides the research community an opportunity to disseminate quality, real-time surface observations to the operational community by utilizing existing MM platforms during ongoing field projects at no cost through MRESS.

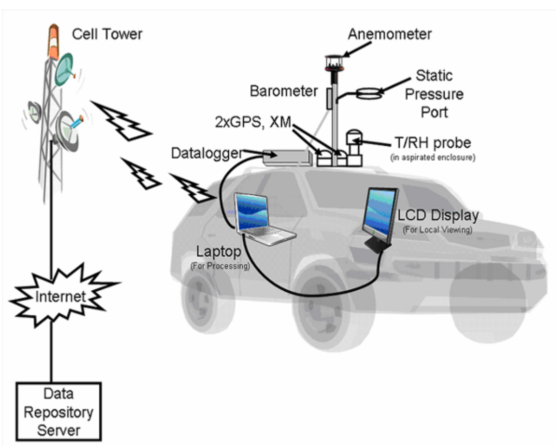

Figure 7: Overview of a basic MM vehicle implementing MRESS technology while in the field.

3.3 *Live Chase Cams*

Increased Internet connection speeds have led to a growing popularity of web-based "weather cams" over the past decade. A wide

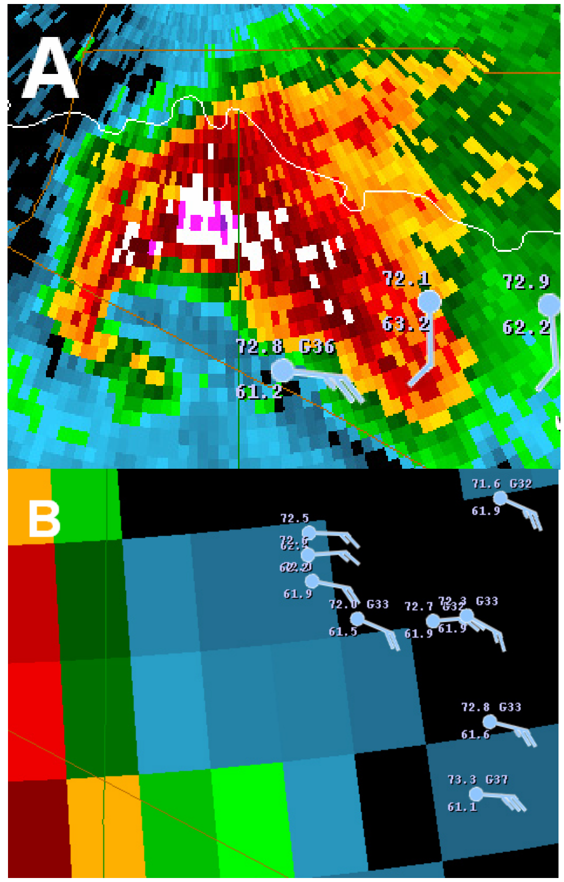

Figure 8: Example of MRESS as a placefile with GRLevelX software on 7 April 2008. (a) Wide view is shown with a (b) zoomed look into the inflow notch. Standard station model in format; temperature and dewpoint (°F), and winds (half barb = 5 mph, full barb = 10 mph).

spectrum of businesses, agencies, schools and individuals (schools, state parks, media, transportation departments, and private residencies) have installed cameras available for public usage. Occasionally, these web cameras serve as an effective tool in support of operational meteorology, such as monitoring convective initiation, storm structure, or snowfall rates. Unfortunately, web cameras are typically confined to populated areas, remain in a fixed position, and transfer only static images. The last decade also brought intense media competition for weather coverage in a few regions in the CONUS. Today in larger television markets where weather is frequently newsworthy, fleets of media vehicles and helicopters are deployed by television stations to transmit both still imagery and live video of ongoing convective weather. Still, this type of aggressive weather coverage does not represent the majority of media markets. For locations such as the rural Great Plains, the opportunity for a real-time view of convective weather is rarely present during warning operations.

Figure 9: Screen capture of a live chase cam in action near Hoxie, Kansas on 22 May 2008. This streaming video was monitored in real-time by the NWS Goodland, Kansas. Video by Matt Grantham.

A strong emergence of live streaming video via the internet by storm observers was noted in 2008. Several NWS weather forecast offices monitored these tools in support of severe weather operations (Fig. 9). The live chase cam (LCC) process allows individuals in the field to broadcast imagery in real-time to a designated location on the internet. A video or computer camera in the field typically mounted to the vehicle dash board feeds into a laptop computer where software encodes the data. The encoded video data is then shipped through the internet to the designated web page. Monitoring the live feed is at no cost and is most frequently compatible with Windows Media Player. With the large number of storm observers streaming live video of ongoing severe convection, an operational forecaster now has the opportunity to visually observe severe storm morphology in real-time. LCC serve as the ultimate ground-truth tool during the warning decision process by providing real-time visualization of storm features and mitigating questionable or lack of reports issues. These tools uphold the old saying ‘a picture (or video) is worth a thousand words’.

4. SUMMARY

The SN, MRESS, and LCC are emerging technologies operated by storm observers that have shown great potential in supporting the NWS warning decision process. These tools are available at no cost to the NWS or individuals in the field. The technologies are available to use and monitor during all times of the year. This is especially true during high-impact events found in the peak severe weather months when large numbers of highly educated storm observers are present. Individuals monitoring these data can incorporate the tools into one situational awareness display through the use of placefiles in GRLevelX radar display programs. The tools provide surface observations, severe reports, and visual confirmation of ongoing weather, aiding in revolutionizing the methods of obtaining ‘ground-truth’ information in real-time. Local NWS weather forecast offices must choose to embrace these emerging technologies and dedicate the necessary resources to sufficiently monitor the existing wealth of information. Ultimately, the partnership bridge these technologies provide between storm observers in the field and the NWS will continue to enhance the warning decision process and increase the flow of relevant real-time information to the public.

REFERENCES

Doswell, C. A. III, 2007: Historical overview of severe convective storms research. Electronic J. Severe Storms Meteor., 2(1), 1–25.

Pietrycha, A. E., and M. A. Fox, 2006: Effective Use of Various Communication Methods during a Severe Convective Outbreak. NWA Digest, 28, 59-64.

Straka, J. M., E. N. Rasmussen, and S. E. Fredrickson, 1996: A mobile mesonet for finescale meteorological observations. J. Atmos. Oceanic Technol., 13, 921–936.