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A WORD OF CAUTION ON THE USE OF SEVERE WIND REPORTS IN POST-EVENT ASSESSMENT AND RESEARCH

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1. INTRODUCTION

The Bow Echo and MCV Experiment (BAMEX) is an observational research study of the life cycles of mesoscale convective systems (Davis 2004). The field phase of BAMEX was conducted from 20 May 2003 through 6 July 2003 over a large portion of the central U.S; the base of operations was the MidAmerica Airport in Mascoutah, Illinois (just east of St. Louis, Missouri).

One of the BAMEX goals was to gather an enhanced "ground-truth" verification dataset for proposed and established mechanisms of severe winds in quasi-linear mesoscale convective systems (QLCSs) (e.g., Trapp and Weisman 2003; Weisman 2001; Fujita 1981). Toward this end, aerial and ground surveys of wind damage were conducted[1] immediately following the occurrence of *presumed significant* QLCSs.

The location and scope of the surveys were guided initially by NWS Local Storm Reports (LSRs) and by weather radar (WSR-88D and airborne Doppler) data. Our working assumption was that the significance of a given event would be a function of its appearance on radar and also be proportional to the number of severe wind reports; significance was also assumed proportional to the number of finalized reports in NOAA's *Storm Data*. As demonstrated below, this often was a poor assumption during BAMEX.

Note here that are not aware of any other way to assess the character of damaging nontornadic winds, since information akin to tornado damage path is uncommon in severe wind reports. By character, we refer for example to the five scales of downburst outflow identified by Fujita and Wakimoto (1981). These range from "burst swaths" of ~ 100 m to "downburst clusters" of ~ 100 km to "families of downburst clusters" of ~ 1000 km.

The objective of this note is to inform the community of some of the problems with assessing the scope and severity of an event based only on

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[1] A brief description of each BAMEX event surveyed by our teams, as well as photo-documentation of these events, can be found at: http://apollo.lsc.vsc.edu/bamex/index.html.

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severe wind reports in *Storm Data* (and initially in the LSRs). Such problems may have implications on severe wind "climatologies," hazard models, etc. Some recommendations are offered.

2. TWO EXAMPLES

In the following two examples from BAMEX, we briefly compare our detailed survey analyses with the corresponding *Storm Data* severe wind reports. It is not our intent to criticize the warning and post-event operations of any forecast office or county emergency management office. Hence, the examples are described without geographic reference.

In the first, an intense cell bow echo (Lee et al. 1992; Klimowski et al. 2004) caused a 30-km long swath of *concentrated*[2] wind damage to trees, pivot irrigation systems, and some farm buildings, based on our ground and aerial surveys. We rated most of the damage F0 (Fujita 1981), though an embedded area of F1 damage was also found (Fig. 1).

In *Storm Data* (and in the LSRs), the event was represented by only two reports located near or at the eastern edge of the damage swath (Fig. 1). The narrative of one of these entries was at least helpful in its portrayal of the type of damage:

> **`High winds did extensive damage north of` *`Town`* `in eastern` *`County`*`. Several farmsteads sustained house, outbuilding, grain bin and tree damage. More than twenty irrigation systems were damaged or destroyed.`**

Nonetheless, the information contained in this and the other report did not adequately depict the area and intensity of the damage. Indeed, one could easily conclude that this was a fairly isolated event.

In contrast, there were several instances during BAMEX in which large numbers of wind reports were listed in *Storm Data* (and initially in the LSRs) for events that we deemed less significant. One such example is shown in Fig. 2. The damage here was due to an extensive bow echo. The *Storm Data* wind reports would qualify this bow echo event as a low- or perhaps moderate-end derecho (see Coniglio and Stensrud 2004). Our surveys revealed only a few scattered areas of concentrated F0-F1 damage (see also Fujita 1981); we obviously could not verify severe wind gusts in absence of damage (see section 3) and we were not even able to verify the damage described in many of the reports (Fig. 2). The narratives of some of these reports were less helpful:

> **`Trees down.`**

From our surveys, this could imply a few bent-over samplings or a large grove of snapped hardwood trees with ~ 0.5-m diameters or something in between.

To summarize, the number (and density) of severe wind reports for these cases from BAMEX served as a poor characterization of the actual scope and magnitude of the surveyed damage. We have attempted to quantify this conclusion by comparing the number of *Storm Data* wind reports (N_{SD}) to the total area of our surveyed F0 damage (A_{F0}). The latter was estimated graphically after

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[2] In this rural case, "concentrated" equates to some damage in nearly each of the 1mi × 1mi sections within the indicated damage swath.

digitizing the F0 contours, which enclose areas of concentrated damage. This ratio of N_{SD}/A_{F0} is 2/130 km^2 = 0.015 km^2 for the first case. As could be anticipated using Figs. 1-2, the ratio is much larger for the second case: 44/400 km^2 = 0.11 km^2. In the future, we will also account for the spatial distance between wind reports, and then consider a number of other BAMEX events.

3. DISCUSSION

We are certainly not the first to raise concerns about reports of severe convective winds. Weiss and Vescio (1998), and more recently Weiss et al. (2002), have noted that the annual number of severe wind reports has increased substantially over the past twenty years. Besides better public education/awareness and an increase in population density, explanations for this increase can be attributed to the deployment of the WSR-88D network, enhancement of storm-spotter networks, and implementation of a national warning verification program (Weiss et al. 2002). These and the policy that a wind damage report must be accompanied by a wind gust report also help explain anomalous spikes in the numbers of severe wind gusts of 58 mph (50 kt), for example (Weiss et al. 2002). In absence of damage, most reported wind gusts presumably are estimated values. This is problematic since estimation of wind speed by a human observer is inherently difficult. In the same vein, assignment of a *single*, peak windspeed to damage to trees, non-engineered buildings, etc., is essentially arbitrary and fraught with potential errors.

These uncertainties as well as the report "misrepresentation" we described above can act to skew our basic understanding of the capacity of MCS types to do damage. In the preceding examples, the large bow echo (as viewed by a weather radar) would likely be perceived (incorrectly) as more intense than the small, cell bow echo.

Longer-term, climatological studies of severe convective wind events are also prone to severe wind reporting errors. Coniglio and Stensrud (2004) acknowledged this in their recent climatological study of U.S. derechos. There is no alternative to the *Storm Data* reports if a reasonable sample size is required, but both underestimates and overestimates should be expected. Finally, models of convective wind hazard suffer from the reporting errors. Unfortunately, we cannot at this time offer a means to predict the effect of these errors.

4. RECOMMENDATIONS

In an ideal world with unlimited resources, our recommendation would be that a post-event damage survey be conducted for all convective wind events associated with a preliminary report of severe wind damage. This would ensure an accurate assessment of the significance of each event, and in turn ensure accurate historical records, climatologies, hazard models, etc. A case for a similar action for tornadoes, hail, and other damaging weather could be made as well. We of course acknowledge that this as an unrealistic recommendation, knowing all too well the time and personnel required for a detailed survey of an extensive bow echo event.

It is appropriate to recommend, however, that damage surveys become an integrated part of future field programs of severe and hazardous weather phenomena. The surveys should include NWS personnel whenever possible. The survey data should be shared immediately with relevant NWS and emergency management offices. In retrospect, we did not do this well during BAMEX, although we did not have the personnel to do this efficiently.

Outside of surveys, other steps can be taken to improve the severe wind reports. We echo Weiss and Vescio's (1998) recommendation that it be stated explicitly in *Storm Data* whether a reported wind gust was measured or estimated. Strictly speaking, this is already enabled in the *Storm Data* system[3]: high wind entries must now also include whether the gust (peak 5-sec averaged wind speed) was estimated (by damage) or measured (by known calibrated anemometers). Nonetheless, guidance still needs to be offered on how to interpret the rather specific "estimates" that continue to appear in the publication. For example, a brief perusal of the February 2004 issue shows estimated gusts ranging from 50, 51, 52, 53, 56, 61, 67, 70, and 97 kt.

We suggest that precise locations be sought always from storm spotters, law enforcement officials, etc., and then that these be translated into descriptive wording in the narratives. Good examples of this from past *Storm Data* entries include estimates of tree size (in terms of diameter and height, rather than "large" or "tall"), exact location of damage (e.g., "near the intersection of County Road 100W and County Road 900N," instead of "2 miles north of *Town*," which can be rather vague in rural areas), and an approximate area over which damage occurred (number of city blocks if urban, number of square miles if rural); an integration of GIS and GPS capabilities into *Storm Data* could help in this regard. Additional descriptors akin to tornado path length and path width could be useful, although a "path" per se is more illusive and difficult to define for since some severe wind reports can be associated with distinct cells as well as large convective systems. Moreover, our experience suggests that typical severe convective systems tend not to damage or "blow down" everything they encounter (Fujita 1981).

Finally, we recommend that separate reports be listed if individual damage sites (e.g., a farmstead) are separated by some distance (e.g., 5-10 km), particularly if damage appears to be significant. A panel to discuss these and other ways of improving severe wind reporting seems warranted.

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[3] As of this writing, these qualifiers do not appear in NCDC's Storm Events online, which is derived from the same relational database as is *Storm Data*.

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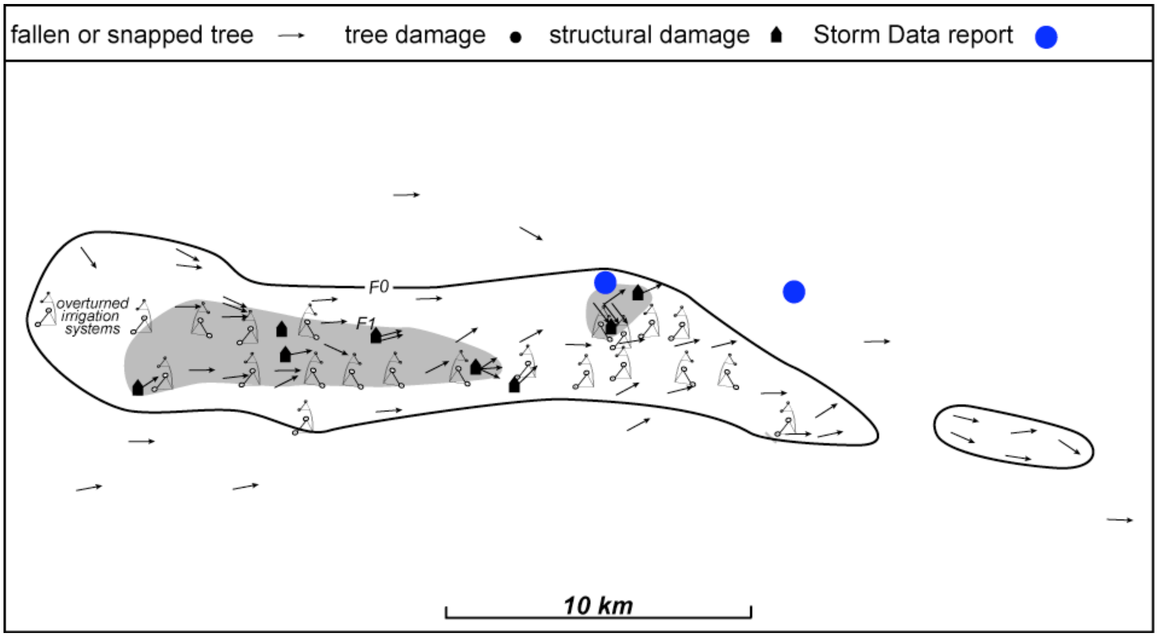

FIG. 1. Survey of damage from BAMEX event. Blue dots show locations of *Storm Data* reports.

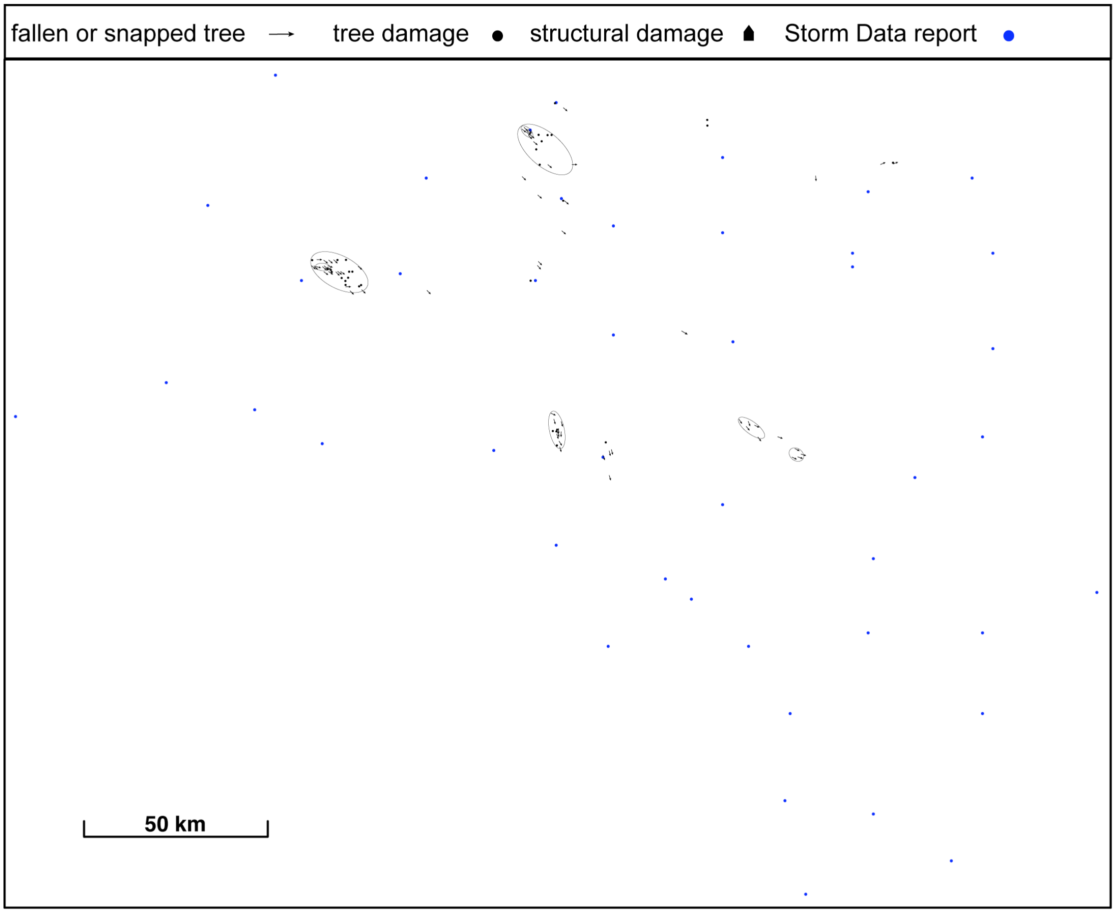

FIG. 2. Survey of damage from another BAMEX event. Note that the length scale in this figure is different from that in Fig. 1.