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AN ASSESSMENT OF BROADCASTERS' USE OF NEW MEDIA AND RADAR TECHNOLOGY IN TV SEVERE WEATHER COVERAGE: BENEFITS, CHALLENGES, AND A NEED FOR TRAINING

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1. INTRODUCTION

Severe weather is a relatively common phenomenon in much of the United States and is a societal threat. Estimates show that weather kills an average of 546 people each year (National Weather Service, 2010). It impacts decision-making in economic sectors such as the airline industry, outdoor recreation businesses, grocery stores, etc.... Droughts, hurricanes, tornadoes, floods, and wildfires cause an estimated $11 billion in damages each year in the U.S. according to the National Oceanic and Atmospheric Administration (NOAA) (NOAA, 2010). Effective communication before and during severe weather might be one way to keep people and property safe.

While scientists' understanding of the atmosphere has greatly improved over the last few decades, little attention has been paid to how people respond to weather and why they take certain actions until recently. Societal impacts research has increased significantly in the last few years, yet literature searches reveal that broadcast meteorologists (broadcasters henceforth for brevity) have been a largely untapped resource. Although they are the most prominent source of severe weather information for people (e.g., Hayes, 2009; Legates and Biddle 1999; Schmidlin and King 1997; Sherman-Morris, 2009), broadcasters have not been consulted by the research community aside from a limited number of studies focused on uncertainty (Demuth, Morrow, & Lazo, 2009), radar (LaDue, Newman & Heinselman, in press), and climate change (Wilson, 2009). Researchers have not studied the technological and social factors that influence broadcasters' communication during severe weather, or gathered their input pertaining to public understanding, interpretation and action during severe weather.

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2. BACKGROUND

This study looks at the influence of new media such as internet and radio simulcasting, National Weather Service (NWS) Chat, storm spotters, blogs, and social media on the broadcast industry. In the past, broadcasters only had to focus on disseminating messages through television. Now they must disseminate weather information via multiple mediums. As more and more Americans access information via the Internet, wireless devices (Horrigan, 2009b), and use social networking tools to communicate (Lenhart, 2009), broadcasters are forced to reach their audiences via new avenues. Because broadcast meteorologists play a vital role in communicating severe and hazardous weather information and new media may be affecting the content and quality of their message, it is essential to understand how they are utilizing these tools.

Another component of this paper looks at the broadcasters' knowledge of dual-polarimetric radar (dual-pol henceforth for brevity). Almost all broadcast meteorologists in the United States will have access to dual-polarimetric radar data in less than three years. Many broadcasters use radar data from the NWS, which currently has 165 WSR-88D (Weather Surveillance Radar – 1988 Doppler) radars scattered across the country (Doviak et al., 2000). While these radars help meteorologists observe the atmosphere, various limitations are associated with them such as inaccurate precipitation estimates, beam blockage, and overshooting. Fortunately, some of the limitations will be overcome when the WSR-88D's are upgraded to have dual-polarimetric capabilities beginning in the fall of 2010 (Warning Decision Training Branch, 2010). Figure 1 shows that unlike conventional weather radars that emit electromagnetic waves in the horizontal plane, dual-pol radars scan *both* horizontally and vertically (Straka, Zrnic, & Rhyzkov, 2000). This technology should improve rain and snowfall estimation, hydrometeor classification, and discrimination between precipitation and non-precipitation echoes (Ryzhkov et al., 2005; Zrnic & Ryzhkov, 1999), but it is not known if and how it will be embraced by the broadcast community. This study inquires about broadcasters' knowledge of the technology as well as how they will utilize the NWS dual-pol radar upgrade whether for analysis purposes behind the scenes, on-air, or both.

The final innovation this study focuses on is one that may not be available for several years. The Center for Collaborative Adaptive Sensing of the Atmosphere (CASA) is developing weather radars that sense closer to the ground and have higher spatial and temporal resolution than the WSR-88D (McLaughlin et al. 2009). CASA has designed an overlapping network of four radars located in southwestern Oklahoma (Figure 2) which has allowed for the development of 3DVar (Figure 3). 3DVar is a unique product because it shows low-level, mesoscale, Doppler-derived velocity vectors, and allows meteorologists to see thunderstorm and tornadic winds at a much smaller scale than is currently possible in operation (Hu et al. 2009). Broadcast meteorologists are a potential user of this product, but it is not known whether and/or how it will benefit them. This study seeks to determine whether broadcasters find 3DVar useful, either behind the scenes as a diagnostic tool, on-air as an explanatory tool, or both.

3. METHODOLOGY

Broadcast meteorologists in the central United States participated in semi-structured interviews regarding the influence of new media and radar technology in TV severe weather coverage. One-on-one interviews were used because they allow the participant to elaborate on what they feel is important (Herbst, 1993) and develop their own frameworks (Crigler, Just, & Neuman, 1990). Interviews also enable the researcher to connect with participants, which produces familiarity and trust between them and the researcher (Kirk & Miller, 1986). Thus, while the researcher leads the interview in a particular direction, the participant also has the opportunity to verbalize messages that are most salient to them. Although the interviewer obtained responses from a diverse sample (e.g., market size, position at station, years of experience), this study is qualitative in nature and is not generalizable to the entire population of broadcast meteorologists in the United States. Nevertheless, this study provides a stepping-stone to understand the influence of technology in TV severe weather coverage.

3.1 Interview Protocol

The interview protocol was based on insight provided by Seidman (1998) and Kvale and Brinkmann (2009) and developed based on the needs of the field of meteorology as seen through literature searches, researcher prior experience, and to inform CASA. In this study, severe weather is defined as potentially hazardous short-fuse weather event such as damaging winds, hail, or tornadoes. Of course, longer-fuse events such as flooding, drought, extreme heat, and winter weather can be dangerous and important as well, but are outside the scope.

The protocol was evaluated by researchers in the fields of communication, meteorology, and geography. It aimed to answer five research questions, three of which are addressed in this paper. The protocol contained demographic questions and questions about broadcasters' use of new media. It also contained questions regarding broadcasters' potential use of dual-polarimetric radar and 3DVar data and the positives and negatives of each innovation. (The questions pertaining to 3DVar were included in the study after several interviews had taken place. While some broadcasters were asked about the tool during the interview, some responses were also solicited via email. Not all broadcasters responded to the email despite several attempts.) Participants were also given a chance to ask their own questions at the end of the interview.

3.2 *Participants*

Twenty broadcasters were interviewed for this study (Figure 4) and it focuses on broadcasters in the middle of the country because it is a prominent severe weather region. Personal network sampling was used to recruit about half of the participants. The rest of the participants were selected based on "sampling logic" (Maxwell, 2005, p. 71) and feasibility so that broadcasters from a variety of demographics including market size, station position, age, gender, and experience were included (Table 1). Participants were located in 12 of the 210 U.S. designated market areas (DMA's). There is no official definition of a small, medium, or large market, so size categories were based on Nielson (2009) rankings, participant insight, and DMA population. In this study, markets with a population greater than one million (1-30) were considered large, between 250,000 and one million (31-115) medium, and less than 250,000 (116-210) small. A couple of the broadcasters also mentioned that the DMA rankings might be different if one only considers severe weather intensity. Only Nielson (2009) rankings were used for simplicity.

The broadcasters were equally representative of the various weathercaster positions at television stations (morning/noon, evening/Chief, and weekend, in most cases), although one should keep in mind that broadcasting is a very dynamic industry and some broadcasters change positions and/or stations every couple of years. So, the market and position classifications only reflect the participants' situation at the time of the interview. Four female and sixteen male broadcasters participated in the study. Twelve have meteorology or atmospheric science degrees and the others have a broadcast meteorology certificate or communication degree. The participants' experience as a broadcast meteorologist range from 1 to 37 years (M = 14.5 years). Specific demographic associations cannot be provided for confidentiality reasons, although quotations and paraphrases are followed by "(I#)" (the number corresponding to the same participant throughout this paper) to provide clarity for the reader.

3.3 Data Collection

Eighteen interviews were conducted May through July of 2009 and the final two interviews were conducted in October 2009. All but one interview was conducted in person (one interview was conducted through email due to circumstances beyond the control of the researcher). Sixteen interviews took place at the participant's TV station while the rest were in a public venue or the researcher's office. These environments provided a comfortable setting for the participants (Taylor & Bogdan, 1998) in which the researcher hoped would facilitate meaningful responses. Interviews typically started and ended with brief conversations about the study, or recent weather events. The researcher also received a tour of the station in some instances, and participants signed a consent form at the beginning of the interview. Interviews were recorded with a small digital recorder and lasted between 36 and 84 min (M = 52 min).

3.4 Data Analysis

The researcher transcribed interviews verbatim. The recording time was marked on the transcript in two-minute intervals so that the researcher could efficiently check data later in the research process. Transcripts were analyzed to determine practical and theoretical findings. This paper focuses on practical findings. Please Butterworth, Veil, & Kloesel (2010) for theoretical findings. The first author listened to all quoted material on the original recordings to ensure accuracy.

4. RESULTS

4.1 Use of New Media

Table 2 provides a summary of the new media being used by the participants during severe weather coverage. The most common new tool is the NWSChat (95%). Some participants are very active in the NWSChat whereas others simply use it as an information gathering source. Internet simulcasting has also become a popular method for disseminating severe weather messages. While industry-wide adoption has yet to occur, the broadcasters who use the technology (60%) only do so during "wall-to-wall" events where coverage can last anywhere from 15 minutes to several hours. Of the participants whose stations simulcast on the Internet, all had only been doing so for a couple of years.

Even though radio simulcasting is not a new tool (some have been using it for over a decade), it was included in the study because not every station has the ability to stream their coverage on the radio. Just over half of the participant's stations use the technology (55%). For the participants in this study, whether their station simulcasts on the radio depends on whether they have a contract with a radio station. Sometimes a single TV station will dominate the market by having an exclusive contract with all the radio stations in town.

About half (45%) of the broadcasters say their stations have designated storm spotters, some paid and some unpaid by the station. Again, although people have been spotting storms since the early 1940's (Doswell, Moller, & Brooks, 1999) and it is not a new idea, participants were asked about it because real-time spotter communication with the TV studio via cell phone, web cam, etc… is only possible using recent technology.

Social networking sites such as Twitter and Facebook are also beginning to influence the way broadcasters communicate during severe weather. A question pertaining to the use of social networking sites was not on the original protocol, but 40% of the broadcasters mentioned using Twitter to disseminate severe weather information to viewers. They had only been using the tool for a couple of months, however. One participant mentioned using Facebook. Of the broadcasters who mentioned having used Twitter during severe weather, all said they had only been using it for a couple of months. However, because the Spring 2009 severe weather season was relatively inactive, the broadcasters did not have many opportunities to use the tool and were unable to provide many examples of its use.

Only one broadcaster said their station has blogged during a severe weather event, although several broadcasters mentioned that their stations have a general weather blog. The main reason for not blogging during severe weather was not having enough staff to absorb the workload. A few participants mentioned that blogs can be useful for post-event analysis, however.

In addition to the new forms of media above, some participants mentioned using other tools such as a web cam, Skype, and digital sub-channels to gather or disseminate information during severe weather.

4.1.1 Benefits. Many comments from broadcasters indicate that using new media during severe weather coverage can be beneficial to both themselves and their viewers. Before looking at individual mediums however, one must consider how the Internet as a whole benefits the industry. After all, many of the new media in this study would not exist without the Internet.

Many broadcasters say much more information is available today than in the past because of the Internet. A chief in a medium market (I20) says the amount of weather information available to them has "tripled" in the last 10 years and that ". . . There's so many more eyes out there looking at storms." A large market morning meteorologist (I16) says they can find everything they need on the Internet whereas they used to rely heavily on their weather vendor. In fact, the Internet provides broadcasters with more information and at greater speeds than previously possible. The broadcasters feel this is advantageous for their jobs. One morning meteorologist in a large market (I14) notes that with the Internet,

> . . . it takes me much less time to get the information I need in order to make an educated decision. So I think at the end of the

> day I do a much better job forecasting. . . . I feel like with these tools that I'm way better off than I would have been.

A medium market chief (I3) also states that the accuracy of their forecasts has improved because of the plethora of information available. Improved accuracy can lead to better decisions for both broadcasters and viewers.

NWSChat. The NWSChat is an instant messaging tool that broadcasters, emergency managers, and NWS forecasters use to communicate during severe weather. It has certainly impacted the broadcast industry in a positive way. The broadcasters are overwhelmingly positive about the NWSChat, making comments such as "[it is] one of the best things we have during severe weather coverage" (I1) and that "it is the quickest way of communication right now" and "the best thing . . . since radar" (I3). One morning meteorologist in a small market (I5) says the Chat is "invaluable" and that it is "almost like the invention of the telephone" in the way it has revolutionized how broadcasters communicate with everyone else in the warning partnership. Some participants (I2, I6, & I18) enjoy the instant communication they have with the NWS. A chief in a medium market (I10) also explains,

> Um, I *love* the fast communications. I mean . . . you can get the severe wind gust reports off the ASOS [Automated Surface Observing Network] network (snaps) like that. Ah, warning decision updates by the Weather Service, those discussions, just being able to click on them and, pull up the bulletins instantly. It's the fastest circuit there is. I mean it beat everything in the house.

It is clear that the NWSChat is beneficial to the broadcast industry.

Internet Simulcasting. Internet simulcasting during severe weather benefits both TV stations and their viewers. Some participants (I12, I16) say that simulcasting can lead to increased advertising revenue and is another way to get the station's brand out to viewers. A large market morning meteorologist (I13) also comments that viewers watching a simulcast are more likely to watch the same station on television. They say,

> There's been a lot of research done by the Pew Research Center about people who, go to your website almost exclusively watch, your newscast. And people who watch your newscast almost exclusively go to your website. So there's a lot of interplay. If you can hook them on the Internet chances are you can hook them on television later that night when they're home.

Another benefit of internet simulcasting is that it does not have to be used during every weathercast or severe weather cut-in to be effective. Whether a station simulcasts their severe weather coverage on the Internet varies depending on the severity of the weather event, staffing, and resources. Stations are not committed to simulcasting every time they go on-air (I7).

One of the major advantages of internet simulcasting to viewers is that they can watch severe weather coverage at work, where most of them do not have TV access. A chief in a medium market (I9) says, "Particularly when people are at work, they really love [the simulcasting], because hardly anyone has a television at work but everyone has a computer." Internet simulcasting also allows a person with a wireless device to take shelter in their basement or other safe place but remain informed about the weather, assuming their power does not go out.

Radio Simulcasting. Similar to internet simulcasting, the radio can provide backup coverage when one does not have access to a TV at work, in a car, etc... A chief in a small market (I18) tells a story about a woman who listened to coverage on the radio when she lost power.

> . . . I remember a lady called and said you know "We were without power." I think she was out in [a town]. Um and their cable . . . went out. I mean they didn't know what was going on but they were able to listen to [the radio station] and [hear] . . . what was up. So you know that makes me feel better. Like people still . . . have a way to listen to us.

Many broadcasters say radio simulcasting is beneficial to viewers because they still have a way to receive weather information if a power loss occurs. One morning meteorologist in a medium market (I2) notes, "If people lose their signal . . . [and] they're in their basement listening to the radio and it's just one advantage we have . . . we can give people, ah, an idea of where the storms are."

Social Networking Sites. Since Twitter was a relatively new medium at the time of the interviews and participants had little experience with the tool, most participants were unable to cite examples pertaining to its use. However, it appears that using social networking sites to disseminate severe weather information may be advantageous to viewers. One participant (I16) told a story about a viewer who was very thankful their station used Twitter. The broadcaster said, "There was an event that . . . someone . . . lost their power . . . but they were getting the Twitter updates on their phone. . . So they kind of knew what was going on even though, they weren't able to see it on TV."

4.1.2 Challenges. While the benefits of new media are plentiful, there are also various challenges associated with them. Limited resources and information overload are the most prominent reasons why the participants in this study are unable to use each medium consistently.

Limited Resources. The biggest reason why a broadcaster might not use a particular new medium is limited resources, both physical and financial. There are so many ways to disseminate severe weather information that it can be difficult for a broadcaster to utilize all of the tools in the time allotted to them. For example, of the media this study was designed to investigate, severe weather blogs are the only form not being used during severe weather. The biggest reason is due to time constraints. One chief from a medium market (I20) says, "If they ask me to [write a blog] I don't know where I'll fit it in my day." Limited resources are especially prominent in smaller markets where stations have smaller staffs. One weekend meteorologist from a small market (I17) comments on the issue,

> . . . in severe weather like, we're now expected to update the crawls, update Twitter, update our website, go on to TV, call radio stations . . . and then send out other forecasts to other radio stations . . . It is too much, for a staff as small as we have.

Comments from the broadcasters also lead one to believe that TV stations do not have enough money to hire more personnel to alleviate some of the workload. Financial constraints can also limit certain forms of technology. For example, some stations do not have enough bandwidth to support internet simulcasting, and obtaining more bandwidth equates to spending more money. In addition, many stations do not have enough money to employ their own storm spotters and pay for the equipment required to support that type of operation (live radar, video feed, etc…).

Information Overload. Aside from limited time and money to support all of the new media, it can be very difficult for the broadcaster to process all of the information. This is especially true during severe weather when they have to monitor information on multiple platforms such as radar, NWSChat, social media sites, etc…. While new media has the potential to increase the efficiency of gathering information, the amount of information available to a broadcaster can also be overwhelming. Sometimes it is difficult for the broadcaster to sort through, process the information, and know on which information to focus. A morning meteorologist in a large market (I13) mentions that looking at multiple data sources can confuse them at times. A chief in a medium market (I12) says the amount of information can sometimes "feel like too much." Despite negative comments however, the participants seem to prefer the current situation to that of the past because forecasts and severe weather coverage are more accurate.

4.2 Dual-Polarimetric Radar Knowledge

None of the participants had access to dual-pol radar data at the time of the study, but were solicited for their knowledge of the technology because it will be available in the near future. Table 3 shows a summary of their knowledge, of which the categories were qualitatively defined. The broadcasters' knowledge ranges from not having heard of it to having fairly extensive knowledge on the subject. The majority of participants had heard of dual-pol and are aware that the main difference between it and the current WSR-88D's is that electromagnetic waves are polarized both horizontally *and* vertically. Some broadcasters were somewhat aware of the benefits of dual-pol, but many were unable to provide specific examples. A typical comment from a broadcaster who had some knowledge on the subject was, "It can show you so much more than the regular radar can just because it's got the horizontal and vertical, and you can get a much better idea of the storm" (I6). In a few instances, some broadcasters stated inaccurate benefits. Only a couple broadcasters seemed very comfortable with the subject. Sixteen out of 20 broadcasters (80%) were aware of the NWS upgrade, but many of them were unfamiliar with deployment timeline.

4.2.1 Benefits. Although the participants do not have a complete understanding of dual-pol technology, some understand there will be some benefits over the current, single polarimetric radar, which might motivate them to use the technology. A chief in a medium market knows that dual-pol radar gives the ". . . size and the shape of the drop" (I3), and a weekend broadcaster (I10) is aware that the technology provides more accurate rainfall accumulation and hail size data. Another chief (I18) says it will be "a tremendously good project." A weekend meteorologist in a small market (I4) said that improvements on the WSR-88D would be helpful in their job. They noted, ". . . anything new, that expands on the addition of the previous radar . . . would be helpful, on-air, 'cause we're already showing it [the radar], so, any of the ways to make it better, the better we'll be." Many broadcasters are excited about the analysis benefits and being able to provide more accurate, detailed information to viewers.

4.2.2 Challenges. One of the challenges to using dual-pol data on television will be to make the products valuable to the viewers and easy for the viewer to understand. Some of the information provided by dual-pol is very complex and it may be a challenge for broadcasters to explain it in a way that makes sense to the viewer, especially given the small amount of time they usually have. Several broadcasters voiced their concern about determining how to display the products in a way that makes sense to viewers. One chief (I9) was very adamant about the need for dual-pol to be useful for the viewer and had many questions about the issue. "What is dual-pol gonna *look* like on TV? How will we take that data and repackage it to make sense to people? I think [those] questions are still out there I think the vendors are still looking at these issues," they said. Another chief (I12) also commented on the subject. "What I want to do is come on there and say is, 'Okay, we *know* we have *heavy*, marble sized hail falling at this location.' Or, 'we have rainfall rates falling at six inches per hour. That really *is* six inches per hour.' Right now it's a guess," they said. Viewers may be able to make more informed decisions if broadcasters can give them very specific hail or rain rate information, but it may be a challenge to display the information in a way that is accurate and easy to understand given the complex nature of the technology. Some broadcasters are looking towards private weather vendors to make dual-pol products suitable for TV. One morning meteorologist in a large market (I16) noted, "I'm assuming [our weather vendor is] . . . working on algorithms to be able to display [the National] Weather Service data. Yeah. And I'm sure they're working with the National Weather Service." A few participants said they will also be looking to colleagues, conferences and specialty magazines for information on dual-polarimetric radar.

Another obstacle to using dual-pol information during severe weather is limited resources. Many of the participants spoke of the poor economy and general state of the television industry as reasons that might keep them from embracing the new technology without the help of the NWS. As one broadcaster (I3) noted, "We contemplated trying to get [a dual-polarimetric radar] here . . . to be the first, or the only people to have dual-pol, in [this state]. But, the economy being what it is . . ." As previously discussed, there are also so many tasks that a broadcaster has to complete everyday (e.g., forecast, prepare graphics, visit schools, call into radio stations) and during severe weather coverage that it can be difficult to find time to learn about new technology. A morning meteorologist in a medium market (I13) noted that time constraints may inhibit them from completing the detailed analysis that may be necessary to utilize the dual-pol information to its full capacity. They said,

> We are somewhat limited by the amount of time we have on a given day to actually put stuff together. . . . I know that my news director is not gonna give me an extra 30 seconds for every weathercast because we have this cool, new dual-pol radar, ah network set up.

4.2.3 Need for Training. Some broadcasters are very excited about the potential benefits of dual-pol, on-air and behind the scenes, but their limited knowledge hinders them from giving specific reasons for using the data once it becomes available. Lack of knowledge and uncertainty about the data and its potential usefulness to themselves and viewers seems to be the biggest obstacle to utilizing the information. Prior to using the information on-air, broadcasters will need to learn how to analyze and interpret the data accurately themselves. Broadcasters are looking toward the NWS to lead the training initiative. One chief (I12) commented, "[the NWS has] the people, *they* have the resources to evaluate dual-pol. Individual television stations do not, at all." Another chief (I9) commented about the need for education on the subject.

> …I am dying to know everything I can about this. Do I know what it is? Yes. Do I know what it's supposed to do? Yes. But analyzing it, in real-time? On television? In front of an audience? Man I need all the information I can get.

The NWS is playing a major role in the implementation of the dual-pol radars, and dual-pol data would be inaccessible to most broadcasters without the NWS upgrade. Most broadcasters do not have their own resources to gather dual-pol information, so they are counting on others to provide the information to them. Broadcasters are relying on the NWS to educate them on the topic. A chief in a medium market (I7) also noted that the American Meteorological Society (AMS) often provides useful information about new concepts or technology, but hands-on learning is the most effective method. They said,

> The [National] Weather Service here does a pretty good job of inviting people ah to come out. They usually have, training sessions on things and then we invite ourselves out there or they'll invite us . . . You know the AMS has put a lot of stuff out there now that ah, is good. Online tutorial kinda things. [But] there's nothing that's, as good as sitting with a Science Operations Officer. . . of the [National] Weather Service, talking to 'em.

4.3 Potential Use of 3DVar

The operational implementation of dual-pol radar will occur in the near future, but a product like 3DVar that is based on an infrastructure of a dense network of radars may not be available for many years. Despite the time lag, participants offer their opinions as to whether and how they might use the product. There is a general consensus among the broadcasters that 3DVar would be helpful behind the scenes and that they could use it as a diagnostic tool. There were differing opinions however, as to whether the product, at least in its current form, is simple enough for viewers to understand or too complex to be shown on-air.

4.3.1 Benefits. It appears that the biggest benefit of 3DVar to broadcasters is behind the scenes. Many broadcasters say they would use the product as a diagnostic tool if it were available in their DMA and that it would be "very" or "extremely" helpful. Some broadcasters say 3DVar could be advantageous in identifying mesoscale boundaries compared to the current WSR-88D infrastructure. A chief in a medium market (I7) said,

> . . . [3DVar] would be extremely helpful in looking at severe storms. We are always looking for the boundary and if storms are getting ready to cross a boundary to see if a tornado circulation will spin up. Sometimes fine lines will show up on our radar or NEXRAD, but sometimes not . . . [3DVar] certainly defines boundaries with the wind vectors.

A weekend meteorologist in a small market (I6) also agrees that 3DVar would be helpful as an analytical tool and lead to more accurate information for viewers. They said, ". . . it would assist me in . . . being able to see where some stronger areas of rotation are and therefore be able to inform the public where I think the more dangerous areas of the storms are."

4.3.2 Challenges. It appears that there are several challenges to utilizing 3DVar in the broadcast industry, the biggest being to determine whether 1) whether it would be more beneficial to show 3DVar than traditional storm relative velocity (SRV) products (Figure 5) and 2) viewers can understand the graphic. The participants' opinions vary on these issues. Some broadcasters feel that viewers would be able to understand the product. For example, a chief in a medium market (I3) says they would consider showing the product to the public because it "is a much easier way to understand the winds in and around a storm." Another chief in a medium market (I7) agrees. "I think we could show it on-air…it's pretty normal looking reflectivity with wind vectors, you should be able to explain that to average folks." "People understand very simple lines like arrows," notes another chief (I18). Some broadcasters also feel the product would be better to show on TV than SRV because small-scale circulations are more easily identifiable. One morning meteorologist in a small market (I5) comments,

> It could easily replace SRV. In a case where we have a good couplet to show on-air the met[eorologist] must take time explaining what a couplet is. [3DVar] more or less shows graphically with the wind vectors what a couplet cannot, circulation.

Another broadcaster (I7) also thinks that 3DVar would be easier for the public to understand than SRV because ". . . folks don't always get the green/red toward/away. This gives them colors that they are more familiar with, yet pinpoints the area of the tornado."

Some broadcasters, however, say that 3DVar would confuse viewers more than SRV. One weekend meteorologist (I6) from a small market thinks 3DVar would confuse the viewer because "360 degrees of possible wind direction . . . looks like a more complex image" and that "people can grasp the towards the radar, away from the radar concept because there are only two colors and thus less going on." Another participant (I10) mentions that 3DVar would inhibit them from showing the "extreme" numerical wind values of the traditional SRV product, which can be an important visual component of TV weather. The broadcaster said, "We like to label things live on the air by clicking the extreme pixels."

Another challenge is making 3DVar suitable for television. Two broadcasters say that because TV screens have a much lower resolution than computer screens, the current product is too cluttered for TV. One of them (I10) said, "I can see it being used on-air if the arrows were thick enough, two or three pixels wide, where they would look good on a home television screen. Computer monitors are much higher resolution than TVs in most cases." While 3DVar provides excellent detail, it may not be possible to show that detail on TV.

A final challenge for the broadcast industry to adopt a product like 3DVar is having time to analyze the data. One broadcaster in a large market (I14) says that they do not always have the time to complete in-depth analysis during a severe weather outbreak. Thus, analyzing 3DVar may not always be feasible. The same participant says that 3DVar might contain too much information to absorb during a major event. Another broadcaster in a large market (I13) agrees, saying that since broadcasters provide a service to an audience across a wide geographic area, they do not always have time to analyze individual storms. Thus, 3DVar may provide more detail than they can handle.

5. CONCLUSIONS

Technology plays a substantial role in TV severe weather coverage. New media are changing the way broadcast meteorologists gather and disseminate information. Whereas in the past broadcasters only had to deliver their message on television, they now have to keep multiple mediums (internet, radio, social networking) in mind. Some new forms of media are being used more than others, which is likely due to limited physical and financial resources. In addition, broadcasters use many data sources on the Internet as well as NWSChat to gather information, but they disseminate information to their audience via multiple avenues. While the amount of weather information helps broadcasters give more timely and accurate information to viewers, that efficiency seems to be counteracted by the number of mediums they are expected to use. This study shows that while viewers have more options for obtaining severe weather information, broadcasters are reaching the capacity of their workload during severe weather events.

In addition to the current issue of determining the best practices of new media, broadcasters will soon have the opportunity to use new dual-pol radar products and may use 3DVar in the future. The participants made it clear that their use of dual-pol and 3DVar will be very dependent on their comfort level with the product(s). Thus, although broadcasters are enthusiastic about the potential benefits of dual-pol and 3DVar, they say that products that are designed for on-air use must be suitable for TV and add value to the viewing experience. Since their dual-pol knowledge varies considerably, many broadcasters will need training to be able to interpret the products and utilize it on-air in the most effective manner. Broadcasters are relying on the NWS to initiate training and would like to work with their local NWS Weather Forecast Offices. Furthermore, CASA, the NWS, and weather vendors should keep in mind that broadcasters may not have time to interrogate individual storms depending on the weather event and number of staff present. Stations with a large staff (four or five people) working an event may be capable of doing their own analyses, but those with a small staff (one or two people) rely on the NWS and vendor products.

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8. TABLES & FIGURES

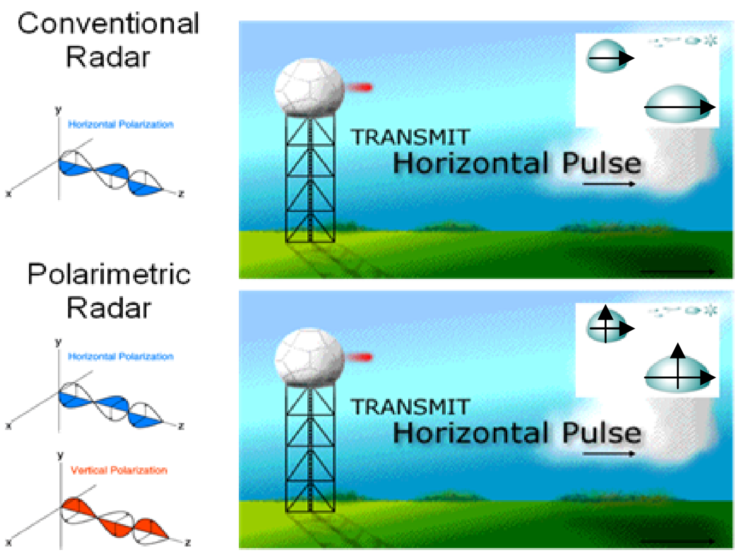

Figure 1: Conventional radar emits a single polarized electromagnetic wave in the horizontal plane, whereas polarimetric radar emits a dual-polarized electromagnetic wave in the horizontal *and* vertical plane. (Image credit: National Severe Storms Lab, http://www.nssl.noaa.gov/dualpol/)

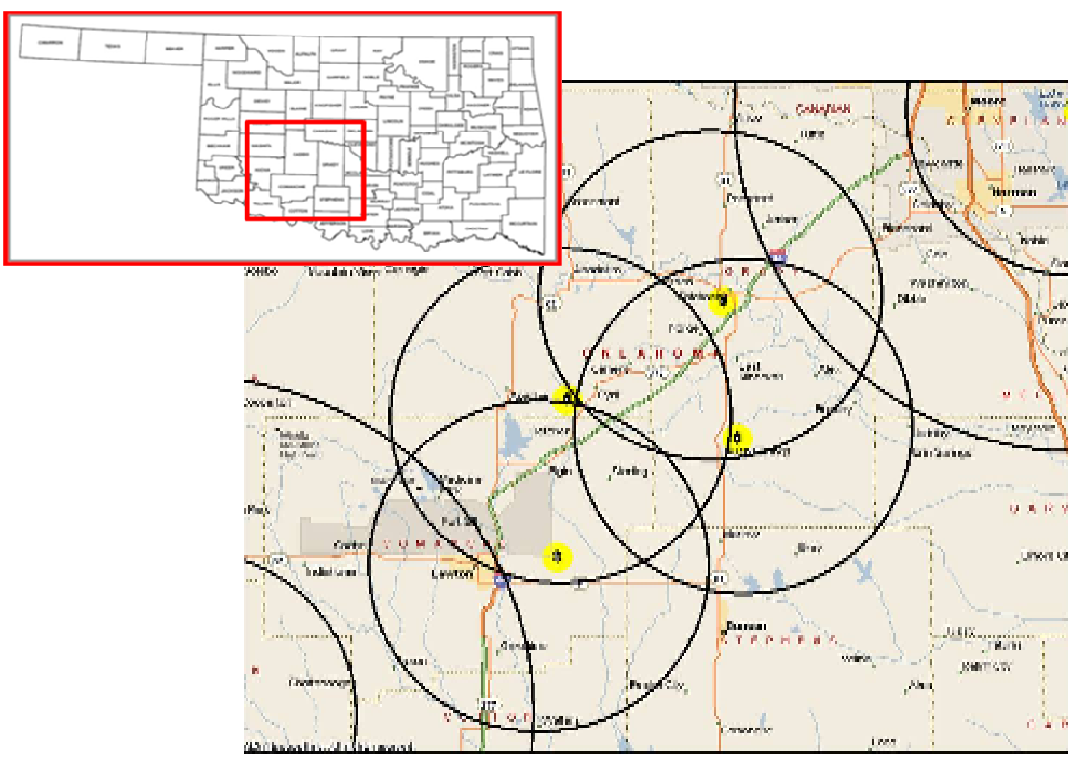

Figure 2: Map of the four CASA radars in southwest Oklahoma with 40-km range rings. Also pictured are two NEXRAD radars: Twin Lakes (KTLX) in the upper right and Frederick (KFDR) in the lower left. Range rings denote 40 and 60km, respectively.

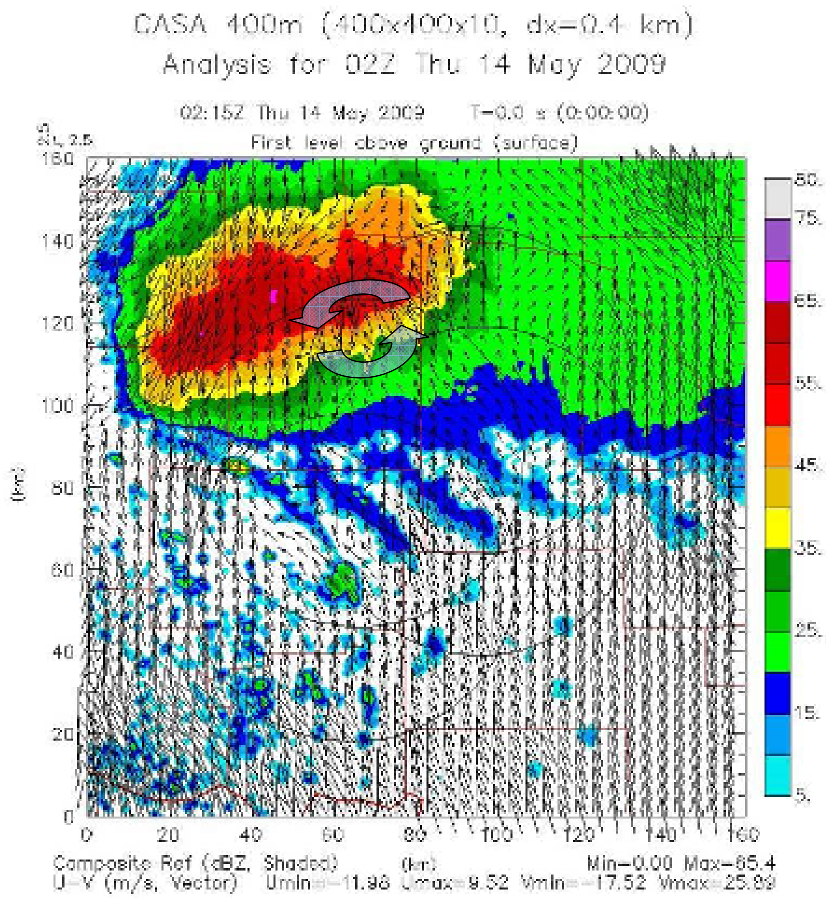

Figure 3: Example 3DVar image from May 14, 2009 with a composite reflectivity overlay showing Doppler-derived wind vectors. The blue arrows point to an area of circulation, which formed an EF-2 tornado that struck two small towns in southwestern Oklahoma.

Figure 4: Summary of the number of participants in each state. Broadcasters from twelve markets participated in the study. Specific demographic associations cannot be given to protect the identity of the participants.

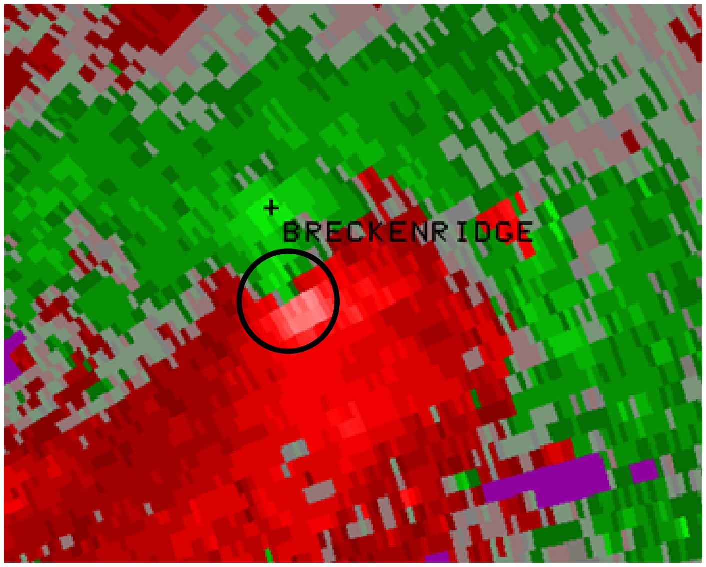

Figure 5: Example of the storm relative velocity (SRV) product showing a couplet indicating a tornadic circulation near Breckenridge, Texas. (Image credit: http://www.srh.noaa.gov/fwd/?n=april09102008)

Table 1: Participant demographic summary. Participants represented various sized markets, station positions, years of experience, and education.

# of Participants in Market	3 Large	12 Medium	5 Small
Positions	7 Chiefs	7 Morning	6 Weekend
Gender	16 Males	4 Females	
Experience	1-37 yrs, *M* = 14.5 yrs		
Education	12 Mteor. Degrees	4 Mteor. Certificates	

Table 2: Summary of the participants' use of new media.

Medium	**Number of participants (%) who use the medium**
NWS Chat	19 (95%)
Internet Simulcasting	12 (60%)
Radio Simulcasting	11 (55%)
Designated Storm Spotters (paid and unpaid)	9 (45%)
Social Network	8 (40%)
Blog	1 (5%)
Other (e.g., digital sub-channel, GR2 Analyst, sky cams, ham radio, text messages, Skype, helicopter)	Varies

Table 3: Summary of dual-pol knowledge

Dual-Polarimetric Radar Knowledge	**# of Participants**
Unaware of it*	2
Had heard of it, knew about h & v**, but not aware of benefits*	7
Knew about h & v, aware of some benefits*	8
Extensive knowledge*	2
Aware of NWS Upgrade	16

*These categories were compiled qualitatively.
** h = horizontal polarization, v = vertical polarization.