UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

DESIGNATED MARKET AREAS (DMAs) AND SEVERE WEATHER COVERAGE: OKLAHOMA-BASED BROADCAST METEOROLOGISTS AND THEIR DECISIONS FOR PROVIDING LIVE, ON-AIR COVERAGE OF TORNADO WARNED STORMS

A THESIS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

MASTER OF SCIENCE

By

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Norman, Oklahoma
2020

DESIGNATED MARKET AREAS (DMAs) AND SEVERE WEATHER COVERAGE: OKLAHOMA-BASED BROADCAST METEOROLOGISTS AND THEIR DECISIONS FOR PROVIDING LIVE, ON-AIR COVERAGE OF TORNADO WARNED STORMS

A THESIS APPROVED FOR THE

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL SUSTAINABILITY

BY THE COMMITTEE CONSISTING OF

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DEDICATION

This thesis is dedicated to my parents, Glenn and Debbie Johnson, whose words of encouragement and push for tenacity ring in my ears. It is because of your love, wisdom, and support that I am able to pursue my dreams.

I also dedicate this thesis to my darling nephew, Bentley Andrew Bright. May the path that you walk on be bright and that success finds you all your life.

ACKNOWLEDGMENTS

This research would not have been possible without the support and encouragement of many people. First, I would like to extend my sincerest gratitude to my thesis advisors, Dr. Jeff Widener, Dr. Kim Klockow-McClain, and Dr. Darren Purcell, for their assistance in the development of this work. They have tested my knowledge and pushed my ability further than I knew possible. As advisors, they were extremely helpful and were a great resource for discussing news ideas during committee meetings and one-on-one discussions. Their guidance, inquisitiveness, and ability to ask probing questions helped me tremendously in my development both as a scholar and professional. I owe my success to their time, commitment, and encouragement. It has been an honor and a privilege to work alongside such talented individuals.

In addition to my advisory committee, I want to thank Dr. Gary Gress for being such a wonderful TA advisor. I could not have asked to work for a more enthusiastic professor who maintains a warm, friendly, and helpful environment. I am grateful for his encouragement and comedic stress relief throughout my time as a graduate student. Dr. Gress displayed peace throughout the storm. Thank you, it was a pleasure working with you and getting to know you.

I would also like to thank the many individuals who cultivated my growth as a researcher prior to entering the graduate program. Dr. Angela Person, Dr. Kim Klockow-McClain, and Dr. Randy Peppler set a strong foundation for my endeavors and were the ones to encourage me to apply for the M.S. Geography program. They are phenomenal mentors and great friends. Dr. Person offered thoughtful life and career guidance throughout the years and always provided an amazing example of professionalism and attentiveness that I strive to emulate every day. Dr. Person's passion for research, rigor, and endless patience helped me tremendously during my initial days as a research scholar. I am incredibly grateful for her guidance.

Later, I worked closely with Dr. Klockow-McClain and Dr. Peppler. I learned a great deal from both of them, and it was through working with them that I discovered my passion for research. Their mentorship has been instrumental in inspiring me to explore perceptions of severe weather risk from place-based and cognitive perspectives. Combined with their generosity and support, Dr. Klockow-McClain and Dr. Peppler allowed me to have complete independence over the direction of my first research project. If it was not for the risk they took, by allowing a novice undergraduate student to work alongside them, I surely would not have had the opportunity to attend graduate school or the amazing career path that has been laid out for me. I thank the both of them for their patience and constant encouragement to think about my own work from numerous perspectives, and I also thank them for never giving up on me even when things were tough for me to understand. Dr. Klockow-McClain and Dr. Peppler are great mentors and role models, both professionally and personally.

I would also like to thank my colleagues at the University of Oklahoma's Department of Geography and Environmental Sustainability, especially Anna Thomas, Dolly Na-Yemeh, and Filo Gomez-Martinez, for always taking the time out of their day to help me no matter the circumstance. I thank one of my best friends, Dalton Vice, for supporting my ambitions and for taking me out of the academic world to have a little bit of fun – such as the time we went sky diving, I never thought I'd do that!

Finally, I thank my parents, Glenn and Debbie Johnson, sister, Tiffany Anders, and other family members for standing by me. I would not be where I am today without their support and encouragement. Thank you for instilling faith in me and for continually reminding me that I am capable through our favorite verse, Philippians 4:13.

"I can do all things through Christ who strengthens me."

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ABSTRACT

The work presented within this thesis draws upon theoretical contributions relating to the geographical understandings of media and communication, Federal Communications Commission (FCC) policy surrounding televised news broadcast operations, as well as relevant literature situated within risk communication, risk decision-making, and spatial cognition science to examine broadcast meteorologists televised coverage of severe weather events. These perspectives can be applied to understand the ways broadcast meteorologists utilize their subjective interpretations of places within their designated market area (DMA) to make decisions surrounding the provision of severe weather coverage. Particularly motivational to this thesis was the 20-22 May 2019 severe weather outbreak that took place throughout Oklahoma and surrounding states. During this event, an observed trend among broadcasters was a noticeable break in providing traditional severe weather reporting as storms moved across the DMA. This work, therefore, identifies potential opportunities for places to receive disproportionate levels of televised severe weather coverage from their local broadcast meteorologist. As a spatial reference, three Oklahoma DMAs are utilized as focal points. Oklahoma-based broadcast meteorologists were surveyed and interviewed about how well they understood, comprehended, and utilized the geographic extent of their DMA. As well, they were asked to explain their perceptions of their viewers during a tornadic event. Findings from this study suggest evidence for particular communities to receive disproportionate levels of severe weather coverage despite continued storm activity within their DMA. Results also find that broadcasters have inconsistent viewpoints about the needs and geographic knowledge of their viewers. This work concludes with a summary of findings and recommendations for improved televised warning communication and further research.

CHAPTER 1

INTRODUCTION

1.1. Overview and Motivation

In an era where many possible sources are available, local television news continues to be the public's primary source for receiving information during a severe weather event (Nunley and Sherman-Morris 2020, Reed and Senkbeil 2020, Mitchell et al. 2019, Pew Research Center 2019, Phan et al. 2018, Silva et a. 2017). When severe weather conditions are favorable for producing tornadoes, local television news and their team of broadcast meteorologists work closely with the National Weather Service (NWS) to monitor the situation, deliver alerts, and provide suggestions on protective action to those who are at risk (Walters et al. 2020, Zhao et al. 2019, Cario 2016, Ebner 2013, Demuth et al. 2009). Indeed, severe weather warnings and effective, reliable weather coverage from a trusted local personality leads to saved lives (Nix-Crawford 2017, Henson 2010). In serving their local communities, broadcast meteorologists have a privileged position that comes with high power and responsibility.

Though it may seem that weather broadcasts have always been with us, the field of broadcast meteorology was revolutionized with the advent of the Federal Communications Commission (FCC) in 1996. Pursuant to the Telecommunications Act of 1996, this law enables the FCC to review its media ownership rules – localism, competition, and diversity - to determine whether they are necessary in the public interest and to modify any regulation the agency determines to be no longer in the public interest (Scherer 2018). The FCC aims to promote localism - i.e., ensuring broadcast stations are responsive to the needs and interests of their communities - and competition by restricting the number of media outlets that a single entity may own or control within a geographic market (Scherer 2018, Smith 2009). Otherwise known as the duopoly rule, this permits entities like ABC, CBS, NBC, FOX, and PBS to own up to two television stations within the same market (Scherer 2018). Furthermore, the FCC uses Designated Market Areas (DMAs) created by the Nielsen Company to determine the geographic regions that apply to the duopoly rule (Scherer 2018, Smith 2009). Nielsen assigns each county in the United States to a DMA based on the predominance of viewers in an area, often centralized around metropolitan areas, combined with rural communities (Scherer 2018). Altogether, the FCC strives for each DMA to incorporate the diversity of viewpoints and perspectives, as reflected in the availability of media content, diversity of programming, as indicated by a variety of formats and content, and outlet diversity, to ensure the presence of various distribution channels (e.g., television, Internet, etc.) within a geographic market (Scherer 2018).

The implementation of FCC media ownership rules propels the race for television ratings and acts as a catalyst for competitive and entertaining weather broadcasts (Henson 2010). Local television stations are keen on severe weather coverage and use the FCC's promotion of competition to their advantage, recognizing that their coverage can be a rating booster as well as an aid to the public (Henson 2010, Smith 2009). To enliven content within their broadcast, meteorologists utilize methods for flexibility and creativity in their messaging, such as their appearance, polish, and gimmicks to create entertaining narratives (Cario 2016, Henson 2010, Demuth et al. 2009). By acquiring Doppler radar and graphical packages like Geographic Information Systems (GIS), local television stations signify that they take severe weather coverage seriously and bestow their broadcast meteorologists with necessary tools to effectively and continuously communicate the potential for dangerous weather with their viewers (Cario 2016, Henson 2010, Demuth et al. 2009). Furthermore, they can utilize numerous communication modes, such as Facebook Live, Twitter, and local station apps, to maximize their outreach (Pew Research Center 2019, Drost et al. 2016, Ebner 2013, Demuth et al. 2009). The FCC, however, does not mandate content selection or presentation within a station's broadcast (Scherer 2018). News media is thereby free to carry out activities that amplify entertainment narratives, whether this is through the use of evocative rhetoric and images, replaying exciting footage, or recounting harrowing moments to increase viewership (Cario 2016, Drost et al. 2016). Regardless, broadcast meteorologists are still responsible for all populations within their DMA and should be mindful of providing timely and adequate information to their DMAs full extent, even in the competitive world of local television.

1.2. Broadcasting Severe Weather When Minutes Count

Broadcast meteorologists are the most visible members of television news, providing their viewers with up-to-date information as severe weather unfolds. How they communicate, however, is often controversial because it is unclear how much of any given natural disaster is preventable or exacerbated by human factors. With such high responsibility, what should arise if a broadcast meteorologist delivers inadequate messages?

Amid the current media landscape, local television news actively warns the public against severe weather threats, and viewers widely trust their local station's coverage (Losee and Joslyn 2018, Nix-Crawford 2017, Ripberger et al. 2015, Trainor et al. 2015, Sherman-Morris 2005, Hammer and Schmidlin 2002). However, there is little to no regulation by the FCC on how a broadcast meteorologist customizes his or her severe weather guidance, thereby increasing his or her risk of facing scrutiny from local viewers if the meteorologist delivers perilous information. Oklahoma City-based meteorologist, Mike Morgan, for example, faced similar consequences from local viewers after advising Oklahoma City-area residents to evacuate south of the projected path of a destructive EF-3 tornado that was forecast to move into the city on 31 May 2013 (Riley and Krautmann 2016, NWS 2014, Cosgrove 2013). The broadcaster's advice was contrary to standard tornado safety procedures and had a substantial impact on residents still dealing with the devastation caused by an EF-5 tornado that struck Moore, Oklahoma, only eleven days prior (Riley and Krautmann 2016, NWS 2014). In this case, it is apparent that messages concerning event severity and necessary safety actions were not consistent, and in some cases, directly contradicting one another. Unfortunately, many residents receiving these different messages were unsure how to respond.

Among the many consequences the broadcast meteorologist faced, such as public backlash and a breach in trust, there were no violations under FCC regulation because the agency is not permitted to control the selection or presentation of the television stations broadcast (Scherer 2018). Therefore, imminent risk information about the EF-3 tornado was subject to be conveyed in any way deemed necessary by the broadcaster. While the broadcaster did openly apologize, claiming to be desperate to help in any way possible, the meteorologist's advice was nevertheless unreliable and dangerous (Cosgrove 2013). The lessons learned from this event confirm a need for effective communication for populations that are reliant upon the media's capability of providing credible information about tornado risk as it unfolds. Furthermore, this event confirms the need for enhanced vigilance due to potentially vulnerable populations, as communication with the public was not effective.

1.3. Noticeable Shifts in Severe Weather Coverage

During severe weather outbreaks with a high risk for tornadoes, local television stations utilize their designated market area (DMA) to provide coverage to communities throughout the entirety of the event (Scherer 2018). Broadcast meteorologists rely on joint implementation of visuals and verbal descriptions for communicating information about tornado threats, including the severity, lead time, and suggested protective action associated with the outbreak. Amongst this, however, research shows there is still a noticeable shift in geographic focus (Cario 2016, Ebner 2013). For example, during the 10 May 2010 Oklahoma City, Oklahoma tornado outbreak, coverage structured for risk communication led by meteorologists transitioned back to traditional news coverage led by anchors when storms were still active within Oklahoma City's DMA (Cario 2016). The same transition occurred the following year during the 22 May 2011 Joplin, Missouri, tornado outbreak (Ebner 2013). As a catastrophic EF-5 tornado barreled through the city, local viewers within the Joplin, MO – Pittsburg, KS DMA expressed feelings of neglect following their local broadcast meteorologist’s coverage of the severe storms (Ebner 2013). As storms exited the urban core, broadcast meteorologists discontinued their live, on-air coverage and provided severe weather alerts via social media platforms (Ebner 2013). The lack of coverage for active storms within the DMAs pose severe consequences for communities in between television markets, and thus motivated work presented in this thesis. Despite the shift in focus most likely being attributable to the majority of the viewing area no longer experiencing the risk for severe weather, the division in traditional coverage suggests a need to understand where broadcast meteorologists focus their attention geographically, and why. These cases show that there is a nationwide problem to adequately reporting severe weather. It suggests there might be times when broadcast meteorologists fall short of providing consistent coverage to communities comprising their designated market area (DMA). Furthermore, it suggests that certain places continually receive disproportionate levels of severe weather reporting, despite their local broadcast meteorologist being responsible for alerting them about hazardous risk information.

1.4. The 20-22 May 2019 Severe Weather Outbreak

An additional motivation for this thesis transpired following the 20-22 May 2019 tornado outbreak, where the Storm Prediction Center (SPC) issued a high risk for severe weather across Oklahoma and neighboring states (Figure 1, 2) (NOAA 2019a). The timing of the high-risk day was particularly ominous for residents of central Oklahoma, as 20th May served as the sixth anniversary for the incredibly damaging EF-5 tornado that struck the region in 2013 (NWS 2014). This time, however, despite the extremely volatile and dangerous meteorological setup, the massive outbreak of violent tornadoes expected on 20th May did not occur, and the anniversary appeared to pass tornado-free.

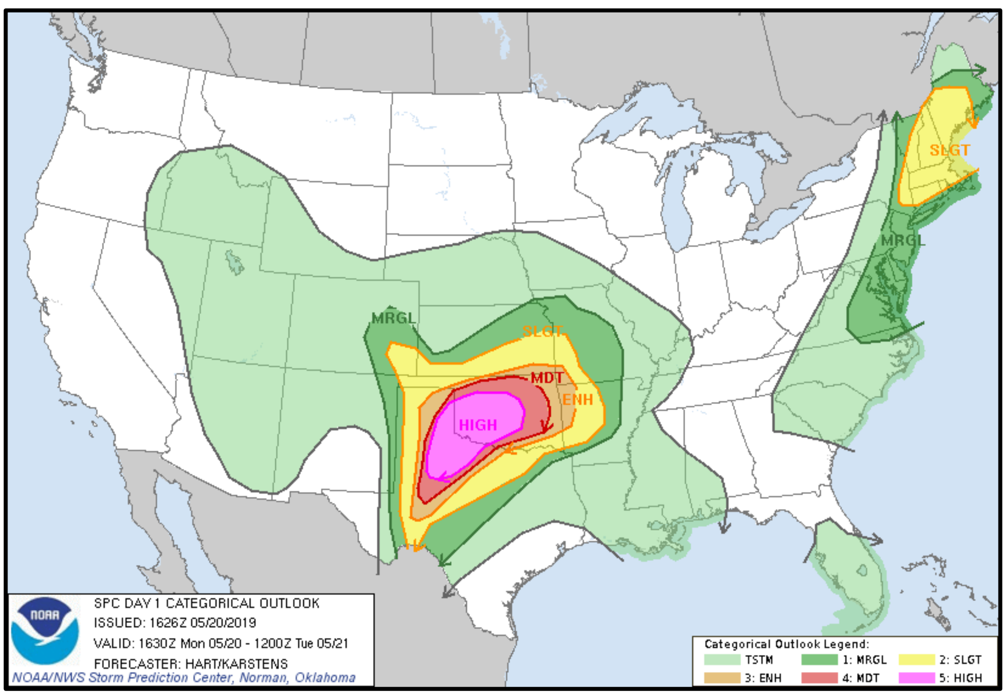

Figure 1. The Storm Prediction Center's (SPC) convective outlook for 20 May 2019, featuring a high risk (NOAA 2019b).

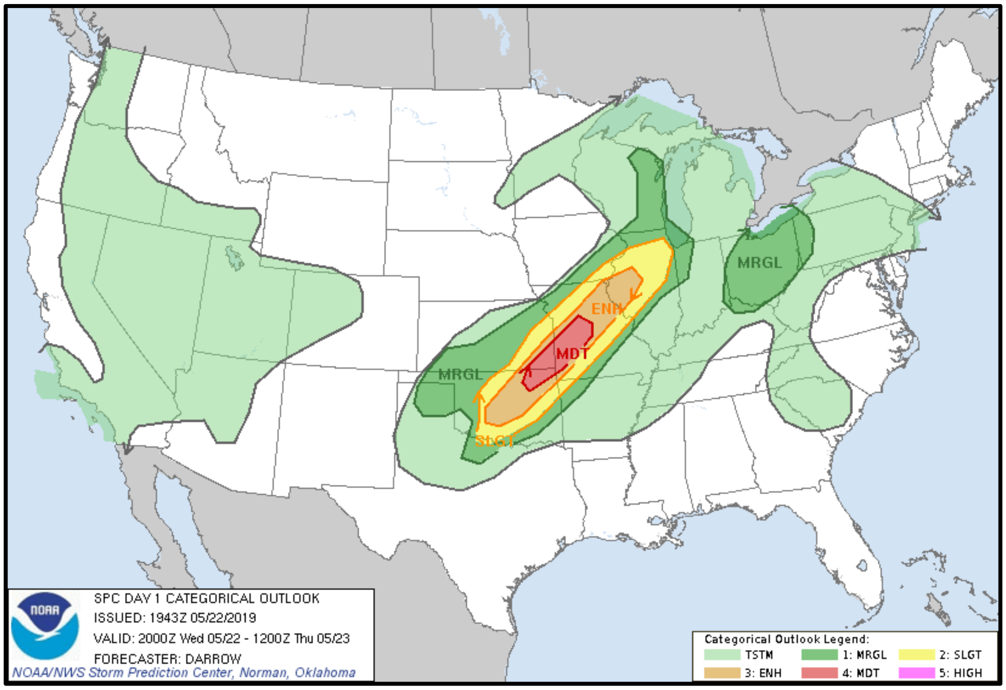

Figure 2. As in Figure 1, but a convective outlook for 22 May 2019, featuring a moderate risk (NOAA 2019c).

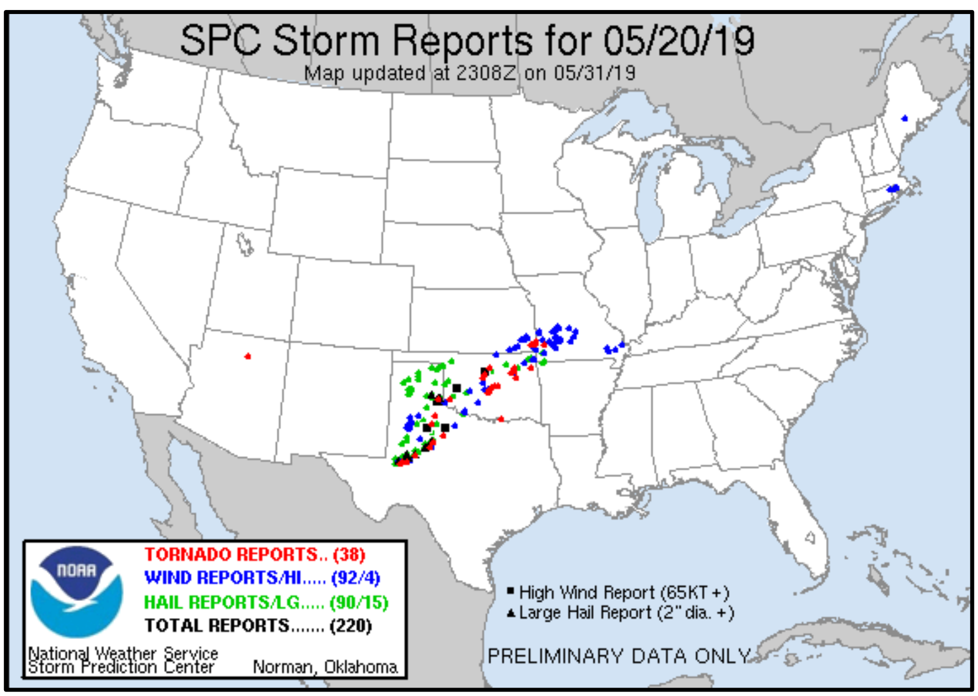

Figure 3. Storm Prediction Center (SPC) storm report for 20 May 2019 (NOAA 2019d).

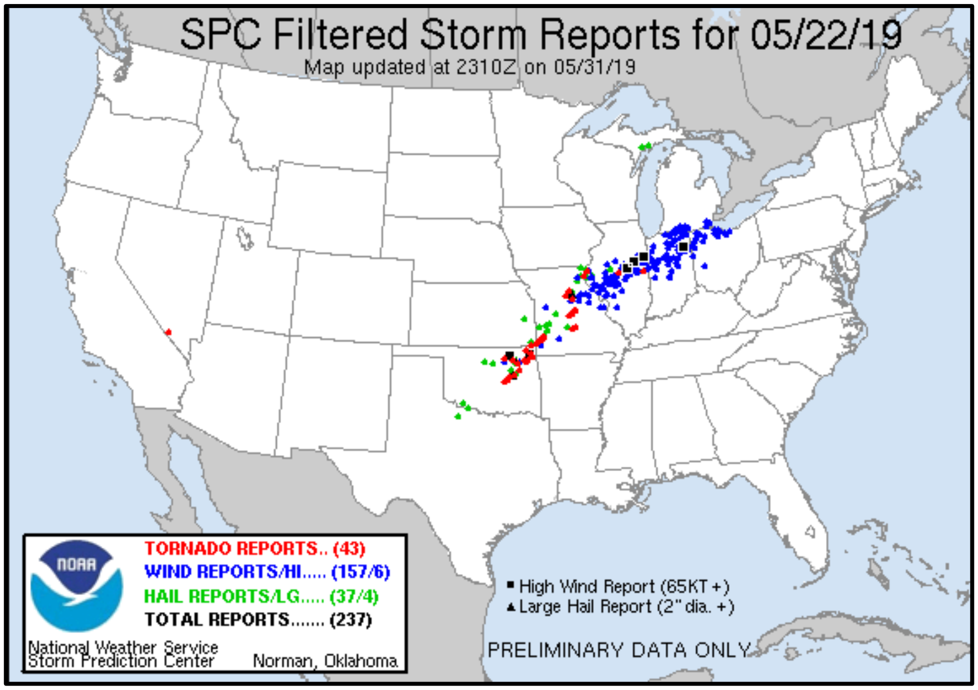

Figure 4. As in Figure 3, but for 22 May 2019 (NOAA 2019e).

While tornadoes did pass through Oklahoma, the majority of the events lingered east of the Oklahoma City metro and into Tulsa, touching down in mostly rural areas (NOAA 2019a). Interestingly, the tornadoes traversed just along the edges of Oklahoma City and Tulsa DMAs (Figure 3, 4). Being a participant viewer during this outbreak, I noticed that as the severe storms moved across Oklahoma, there seemed to be a noticeable break in traditional severe weather coverage between Oklahoma City and Tulsa DMA broadcasters. As storms exited the Oklahoma City-metro, live coverage among Oklahoma City broadcasters became incredibly inconsistent, with some of Oklahoma City station's ending their wall-to-wall coverage despite communities within their DMA still being under warning. As the storms entered Tulsa, some stations did not provide traditional wall-to-wall coverage and continued with regular programming. While broadcast meteorologists are not required to provide continuous coverage for counties falling outside of their DMA, the irregularities in coverage for counties within the DMA had the potential to pose serious consequences for residents – likely leaving them feeling strained and with limited access to sources containing information about the tornado's trajectory and timing.

After witnessing the discrepancies among local stations severe weather coverage, it became increasingly clear that the gray area behind a broadcast meteorologists' provision of wall-to-wall coverage becomes even murkier when the storm is between viewing markets. At times, television media faces barriers that prevent broadcast meteorologists from engaging in severe weather reporting, which ultimately led this thesis to gain a more complete understanding of the decision-making processes surrounding a broadcast meteorologists' choice to provide, or discontinue, televised coverage as storms move throughout a DMA. It is also understood that broadcasters use certain processes for monitoring activity across a region and utilize geography as a setting for discussing severe weather risks. It is, therefore, of equal importance to explore how broadcasters utilize and interpret space within their DMA as part of their decision-making process for constructing severe weather coverage. This research will begin to reveal how broadcasters acquire and use spatial knowledge about their DMA to determine the geographic scope of their coverage – especially instances where there is a noticeable shift in coverage.

1.5. Thesis Objectives, Approaches, and Organization

Broadcast meteorologists are a rarely researched group from which much can be learned. Research devoted to understanding the decision-making process among broadcast meteorologists largely evaluate whether broadcasters can objectively modify their delivery methods to assist viewers in making informed decisions during severe weather events, typically through the analysis of specific elements contained within a severe weather broadcast (Walters et al. 2020, Cario 2016, Ebner 2013, Demuth et al. 2009, Sherman-Morris 2005). Only a few of these studies make note of the barriers in televised risk communication and demonstrate that rural communities are less likely to receive as much severe weather coverage than nearby urban towns (Walters et al. 2020, Cario 2016, Ebner 2013). Observationally, this suggests that rural residents are a segment of the population that need more focus and attention from broadcast meteorologists as a severe weather event unfolds. Despite these findings, there is little research devoted to understanding why some places have inadequate warning communication. This thesis will fill the gap in existing literature by providing a more explicit analysis of factors impacting a broadcast meteorologists decision to provide severe weather coverage, specifically through studying how their own perceptions of space and place relative to their designated market area influence the geographic focus of their coverage throughout an event. Three prevailing themes are discussed in detail:

Objective 1: Investigate how broadcast meteorologists make decisions regarding when to provide, or discontinue, their live coverage of severe storms.

Objective 2: Explore how broadcast meteorologists understand and utilize their designated market area (DMA) in a geospatial context based on their decision to provide or discontinue severe weather coverage.

Objective 3: Identify broadcast meteorologists' understanding of their viewing audience and how such preconceptions shape the way information is communicated across a DMA.

While broadcast meteorologists utilize their designated market area (DMA) to guide their severe weather coverage, a combination of factors exist that impact their decision to provide adequate and consistent reporting throughout the entirety of their DMA. These factors, generally, include their subjective interpretations of space relative to their DMA, such as the geographic extent and breadth of counties included within their viewing market. Furthermore, this includes their preconceptions, interpretations, and understandings of particular places within their DMA, such as their opinions regarding the way communities receive and respond to their televised coverage. As a consequence of these interpretations, there are times when some counties within a DMA do not receive the same level of extensive coverage. This was seen during the 20-22 May 2019 tornado outbreak across the state of Oklahoma and has been noted by researchers in prior studies (Walters et al. 2020, Cario 2016, Ebner 2013).

It is important to research perceptions among broadcast meteorologists because we can compare their perspectives with insights from previous research and identify potential disparities between broadcast meteorologists' approach to communicating tornado warnings throughout a DMA as well as the public's access, knowledge, and use of such warnings. Pinpointing discrepancies as well as identifying potential shortcomings in coverage can help broadcast meteorologists be better informed and hone their messages to communities that otherwise might not have received coverage as needed.

The present research utilizes geographic information systems (GIS) to qualitatively identify the research objectives outlined above. It employs an innovative survey approach in which Oklahoma-based broadcast meteorologists utilize an interactive map to record their understandings for providing severe weather coverage to the entirety of their DMA. Additionally, semi-structured interviews allow for the elicitation of information expressed in the original survey to be presented cartographically. In utilizing qualitative GIS, this thesis incorporates commentary provided by broadcast meteorologists as a frame for spatial analysis and visualization of where broadcast meteorologists focus their attention, and why. This approach gives insight into how the present dynamic among local broadcast meteorologist's dissemination techniques compel risk communication geographically. Furthermore, this research provides local broadcast meteorologists with the opportunity to connect and collaborate about perceived reporting strategies across the state.

To this end, the research objectives presented in this thesis are organized into four chapters. Chapter 2 places the present study within a geographical context of media and communication theory and relevant policy regarding televised news broadcasts delineated by the Federal Communications Commission (FCC). This section also provides an in-depth review of current literature in risk communication, risk perception, and cartographic cognition with respect to media exposure via live television broadcasts of tornado outbreaks. Chapter 3 contains the present study, including the methodology and results, and is formatted for submission to the American Meteorological Society's scientific journal, *Weather and Forecasting*. In Chapter 4, I conclude with recommendations for improving televised risk communication for counties within a DMA that are often overlooked as severe weather events unfold. The manuscript concludes with a better understanding of how broadcast meteorologists utilize spatial domains (e.g., DMAs) to communicate severe weather risks, and provides a groundwork for how broadcast meteorologists can meet the needs of those in their DMA who are most at risk. In doing so, this thesis provides a novel way of helping broadcast meteorologists better assist their viewers as well as mitigate disasters in the long-term.

CHAPTER 2

LITERATURE REVIEW

2.1. Overview and Outline of Chapter

This literature review provides an account of current knowledge regarding geographical approaches to understanding severe weather communication through televised media. The review first outlines media policy stipulated by the Federal Communications Commission (FCC), including competing demands and localism practices within television markets and how they affect severe weather coverage. Next, the review summarizes present literature regarding televised broadcast performance during severe weather events, including studies on reporting strategies and warning dissemination techniques, risk perception following media exposure, cartographic cognition and literacy, and geographic focal points of televised coverage. Lastly, the review provides with a synopsis of perceptive contributions to the geographic study of media and communication theory, specifically analyzing theoretical relations between space and place as they are presented in televised media. The review concludes by asserting that broadcast meteorology, as a discipline, is spatially dis-embedded. Thus, highlighting the need for a practical examination of televised risk communication through the lens of geography and cognitive science.

2.2. The Use of Spatial Thinking as a Framework for Understanding Broadcast Meteorology

Spatial thinking is an essential skillset in the field of broadcast meteorology. Broadcast meteorologists must perform cognitively complicated tasks that involve analyzing spatial data from satellite images, radar, and remote sensors, while also digesting output from numerical forecast models. Broadcasters, then, take on the role of lead communicators by interpreting this complex weather information and presenting it in a way that their viewing audience can easily understand. In doing so, broadcast meteorologists rely heavily upon their recognition of exclusive geographic areas, known as designated market areas (DMAs), to understand spatial relations and depict demographic similarities and differences among their viewing audience. Spatial thinking, in this way, is not static. Broadcasters arrange their televised coverage around interpretations of communities throughout the DMA and continually adjust the way they speak about the pattern, trajectory, and relation of storms as they move across the market.

Prior studies in geography, spatial cognition, and risk decision science have exposed revelatory and practical insights about broadcast meteorology. These studies suggest that meteorological personnel (i.e., forecast meteorologists and broadcast meteorologists alike) do not have a clear understanding of the reasons behind people not seeking shelter and rate this as a high priority for future research (Walters et al. 2020, Sherman-Morris et al. 2018). Additional studies reveal that meteorologists desire a better understanding of how well people understand warnings (Ripberger et al. 2019, Drost et al. 2016, Joslyn and Savelli 2010), what actions they take upon receiving a warning (Klockow-McClain et al. 2019, Zhao et al. 2019, Klockow et al. 2014), and how to best communicate uncertainty (Sherman-Morris et al. 2018). Insights about these desires are often embedded within other areas of research as well, such as those examining the influence of false alarms (Ripberger et al. 2015, Trainor et al. 2015), the effect of color salience and interpretation of warning displays on public response (Klockow-McClain et al. 2019, Zhao et al. 2019, Drost et al. 2016, Nagele and Trainor 2012), experiential factors influencing future warning response (Peppler et al. 2018, Klockow et al. 2014), and perceptions among meteorological personnel for improved decision-making (Reed and Senkbeil 2020, Walters et al. 2020, Sherman-Morris et al. 2018, Cario 2016, Ebner 2013, Demuth et al. 2009). However, the way that specific spatial cognitive factors affect performance and communication of severe weather risks across different geographies is an under-investigated area, yet one that may yield insight into how to best train and improve broadcast meteorologist's communication efforts. Thus, identifying significant cognitive factors for facilitating televised coverage of severe weather events requires a critical examination of broadcast meteorologists understanding and utilization of spatially oriented designated market areas (DMAs).

2.3. Federal Communications Commission (FCC) Media Management Policy

Despite the rapid development of multiple communication sources (e.g., Internet, smartphone apps, Facebook, Twitter, etc.), television has always remained the most popular medium of choice for receiving information (Nunley and Sherman-Morris 2020, Reed and Senkbeil 2020, Pew Research Center 2019, Phan et al. 2018, Scherer 2018, Smith 2009). This longstanding presence and popularity are largely attributable to its adaptive capabilities, such as the capacity to provide content across multiple platforms and places. Thus, television remains the last of the major communication mediums (Radio, Newspaper, etc.) to be displaced by the Internet.

However, prior to the dawn of the digital era, television's esteem brought questions about its content and how it should be regulated. The establishment of the Federal Communications Commission (FCC) in 1934, later amended by the Telecommunications Act in 1996, helped to regulate and oversee telecommunications, including content via radio, by setting various rules relating to broadcast programming and operations that individual television stations must comply with (Scherer 2018). Specifically, the FCC's regulations regarding televised media ownership emphasize the promotion of three rules: diversity, localism, and competition (Scherer 2018). First, the FCC's media ownership policies seek to encourage distinct types of diversity, including the diversity of viewpoints and perspectives, diversity of programming format and content, and the diversity of outlets, which ensures that residents within a geographic market are able to receive multiple distribution channels (e.g., television and Internet) (Scherer 2018). In addition to promoting diversity, the FCC promotes localism and competition by restricting the number of media outlets that a single entity may own within a geographic market. Localism addresses whether television stations are responsive to the needs and interests of their communities, and competition is evaluated in accordance to whether television stations have adequate incentives to invest in diverse news and public affairs that are tailored to serve viewers within their communities (Scherer 2018).

Televised news broadcasts are distinctly products of local media, and the FCC requires broadcasters to serve the needs and interests of the local communities to which they are licensed (Scherer 2018, Smith 2009). In doing so, the FCC also requires content to contain a variety of viewpoints, topics, and voices (Scherer 2018, Smith 2009). However, to encourage competition, the FCC created the duopoly rule to restrict the number of media outlets that any single network (e.g., ABC, CBS, Fox, and NBC) may own or control within a geographic market (Scherer 2018, Smith 2009). Each television station combines the three incentives and the FCC evaluates whether stations have adequate broadcasts that contain diverse local news that are tailored to serve the viewers within their communities (Scherer 2018). Moreover, the FCC ensures communication is readily available to all people without discrimination on the basis of race, national origin, or sex (Scherer 2018, Smith 2009).

In defining the geographic markets, the FCC uses designated market areas (DMAs) created by the Nielsen Company to outline local television markets. Presently, Nielsen has constructed 210 DMAs by assigning each county in the United States to a specific market (Figure 5) where the predominance of viewers receives the same televised broadcast content from a station licensed to operate within the geographical area (Scherer 2018). Thus, the FCC uses DMAs to determine the geographic regions that apply to the duopoly rule (Scherer 2018). These markets are ranked based on size of population included in the region, not region size. This means DMAs can include multiple metropolitan regions, they can divide cities, or they can overlap. In other words, DMAs can coincide or overlap with one or more metropolitan areas and rural regions with few significant population centers can also be assigned individual DMAs (Figure 5). Conversely, very large metropolitan areas can sometimes be subdivided into multiple segments (Figure 5). Figure 5 (below) contains nationwide DMA boundaries provided by The Nielsen Company for 2018-2019. It is worth noting, too, that while media may overlap in some areas, such as people residing on the edge of a television market receiving television news from a neighboring market, the DMA incorporates the viewing and listening habits of residents within a specific defined region. In this way, it is possible for residents in between markets to receive multiple viewpoints and narratives for news stories.

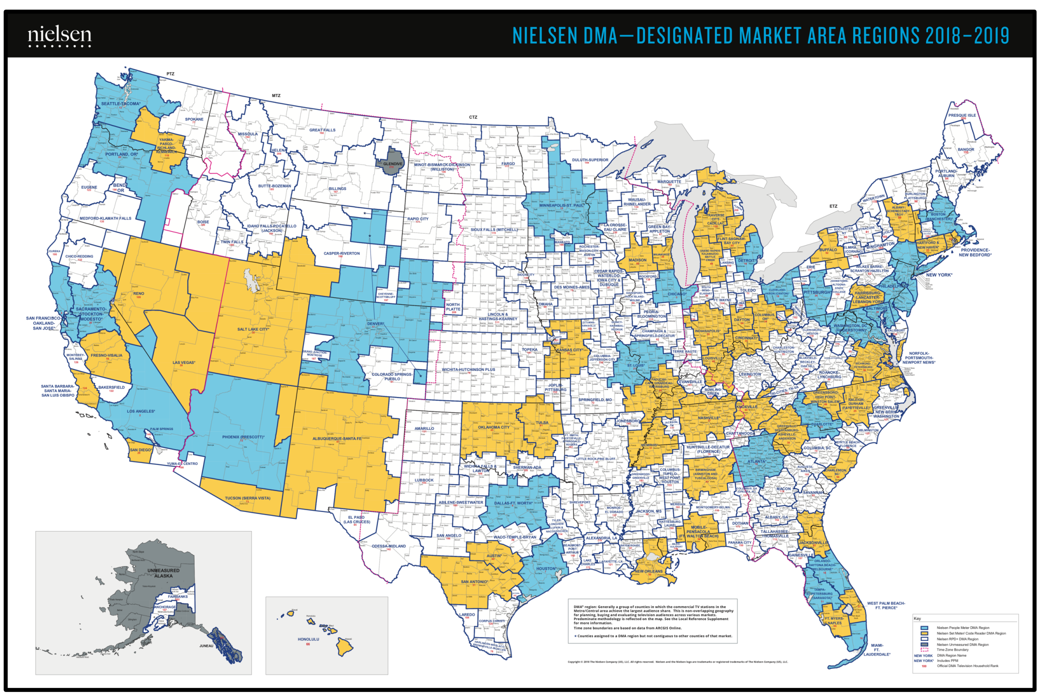

Figure 5. Nationwide Nielsen Designated Market Area (DMA) regions for 2018 – 2019 (The Nielsen Company, LLC 2018).

Designated market areas (DMAS) are most often used to measure viewing audiences, such as audience demographics as well as the products they are consuming (e.g., TV shows, local news shows, etc.). The internet has also changed the way companies use DMAs and has evolved with a pivot away from solely geographical considerations, thereby ensuing televisions capability to transcend images of space and place through multiple media outlets. Nevertheless, DMAs remain an incredibly effective way for television stations to target their audience and reach their marketing goals.

2.3.1. The Impact of FCC Media Ownership Policies on Local Television Broadcasts

In television's history, the FCC's involvement in media management has proven particularly controversial in its policy endeavors (Scherer 2018, Smith 2009). The FCC's implementation of the duopoly rule forced television networks to consolidate ownership to only two television stations in a given DMA under the premise that one company may have too much influence on a particular DMA if not enforced. Prior research examines the relationship between duopolies and its effect on the supply of local news programming. Smith (2009), for example, investigated whether stations in common ownership aired greater quality and quantity of local coverage following duopoly consolidation as compared to pre-consolidation. The study first measured two of FCC's regulatory policies, localism and diversity, for two local stations in Jacksonville, Florida – ABC-affiliate WJXX-TV and NBC-affiliate WTLV (Smith 2009). Four years after the implementation of the duopoly rule, however, the two TV stations merged together as First Coast News (FCN) (Smith 2009). Smith's (2009) analyses compare newscasts for the two stations before consolidating to First Coast News (FCN), and then compares newscasts from FCN to the two TV stations when they were owned by separate companies (Smith 2009). A total of 60 newscasts and 1,048 stories were analyzed and coded for localism and diversity measures;

localism referred to the geographic focus of coverage and diversity referred to the range of topics, stories, and voices featured within the broadcasts (Smith 2009).

Results from Smith's (2009) study indicated local television ownership consolidation following the creation of the duopoly rule translated to significantly higher quality coverage in some content areas but not others. Specifically, the amount of time devoted to local news post-consolidation increased, including time spent covering local government, politics, and community growth; but the amount of time dedicated to commercials, weather, and sports decreased (Smith 2009). Most striking was the dramatic increase in local news coverage. Not only did the proportion (e.g., representation of stories across the entire DMA) of local news stories increase, the amount of time allocated to providing local coverage also increased. Thus, locally produced news and the geographic focus of coverage increased significantly after the creation of the duopoly rule. Notably, there was no significant increase in local sources or the diversity of sources (e.g., allocation of reporters) appearing in news coverage (Smith 2009).

Other studies complicate Smith's (2009) findings, though. Yan and Park (2009) also examined whether or not local television stations increased their local news programming following becoming a duopoly station under common ownership. They hypothesized that a duopoly station would broadcast more local news than a non-duopoly station located in the same market or in a different market (Yan and Park 2009). The study randomly sampled 116 television stations across the United States, among which 40 of the stations were duopoly while the remaining 76 were non-duopoly (Yan and Park 2009). For each of the television stations, the authors constructed a 2-week sample of programming schedules published respectively for 1997 and 2003 from Turner Media service (SMS) (Yan and Park 2009). Data provided by TMS contained a number of useful descriptive fields for identifying local news programming and were used to classify each television program as local public affairs or local news (Yan and Park 2009). Results indicated that in 2003, 5 years after the FCC's creation of the duopoly rule, duopoly stations did not broadcast more local news than non-duopoly stations from either duopoly markets or comparable markets without joint ownership (Yan and Park 2009). Thus, duopoly stations did not provide more local news than their non-duopoly counterparts, nor did these stations devote more time to local news once becoming jointly owned, which is contrary to Smith's (2009) findings (Yan and Park 2009).

Unfortunately, scholarly research relating to these studies is sparse; future research is needed that examines the effects of common local television ownership on the quantity and quality of local broadcast news. Discoveries from Smith's (2009) and Yan and Park's (2009) studies provide much needed evidence regarding the alleged benefits of the current television duopoly rules. The current television duopoly rule does not seem to provide sufficient evidence for encouraging more local programming. Amidst these findings, it is worth mentioning that the FCC's rules regarding media ownership are rather vague. The FCC does not control program content, meaning, individual television stations have the ability to select their own mediums (e.g., television, social media, Internet) for distributing information in response to local viewers and consumer demands (Scherer 2018). In other words, the FCC is barred by law from preventing stations from broadcasting any point of view, as long as the messages contain pertinent information to the local communities by which they serve.

Taken together, the FCC's three media ownership policies – competition, diversity, and localism – contribute to the growing variety of perspectives and presentations in the news. These goals also allow broadcasters to have flexibility in determining the geographic scope of their news coverage. The variable for geographic scope, in this sense, refers to the geographic area to which the topic is relevant to the news source's location, which involves focusing news coverage on the interactions and encounters between cultures and spaces within a DMA. Therefore, the existing federal regulations allow each local television station within a DMA to share their own viewpoint of news information, and such variations in televised broadcasts allow viewers to receive multiple perspectives on unfolding events.

2.3.2. Legal Liability for Televised Severe Weather Broadcasts

One of the stipulations of a broadcast license from the FCC is that television stations exist to serve the public interest, which is a malleable concept to ensuring that the media represents what matters to everyone in society. A more objective definition of the public interest is one that is based on honest and transparent balancing of news stories concerning its citizens and local affairs. As such, the FCC requires all broadcast stations to make emergency information readily accessible to the public through the use of an emergency alert system (EAS) (Federal Communications Commission 2020). The emergency alert system (EAS) is a national warning system designed to deliver important emergency information, such as weather and amber alerts, to affected communities (Federal Communications Commission 2020). The FCC, Federal Emergency Management Agency (FEMA), and the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) work collaboratively to implement this rule at the federal level. While FEMA is responsible for national-level EAS activation and tests, the FCC manages EAS standards, procedures, and protocols that each television station must follow during an emergency situation (Federal Communications Commission 2020). The majority of EAS alerts are issued from the NWS in response to severe weather events.

Current FCC rules require broadcasters and television operators to make certain emergency information accessible, in English, to persons who are deaf or hard of hearing, and to persons who are blind or have visual disabilities (Federal Communications Commission 2020). This means that certain information about an emergency must be provided in both audio and visual formats. Examples of such information include immediate weather situations, such as: tornadoes, hurricanes, floods, tidal waves, earthquakes, icing conditions, heavy snows, widespread fires, warnings and watches of impending weather changes. While there is no specific federal law requiring local broadcast meteorologists to provide extensive coverage of tornado warnings, the FCC does require a broadcast meteorologist to operate in the public interest by providing programming that is necessary or important to its local area (Federal Communications Commission 2020). Therefore, television stations provide severe weather coverage, to varying degrees, depending on the importance of severe weather in that station's geographic area.

The way broadcast meteorologists disseminate severe weather warning information, however, is often left to the discretion of the meteorologist and members of station management. Typically, tornado alerts and warnings are communicated through cut-ins, which can either be full-screen graphics indicating that a tornado warning is in effect or in-depth video cut-ins with broadcast meteorologists providing more specific information about a storm's risks (Coleman et al. 2011). Some television stations may also utilize "crawls" or "bugs" to disseminate warning information or provide updates without the necessity of interrupting programming (Coleman et al. 2011). A crawl is simply a stream of text that moves across the bottom of the television screen and a bug is usually a polygon places over programming in one corner of the screen.

How liable, then, is the federal or state government if television stations provide inadequate or inaccurate forecasts? Klein and Pielke (2002) provide an analysis of legal precedents for weather forecast information, including reviews of several court decisions resolving lawsuits against federal and state governments for inaccurate or inadequate forecasts or failure to issue weather warnings that caused injury or loss. They examine claims barred by immunity under the Federal Tort Claims Act (FTCA), which is an act that allows the government to be sued for injury or loss caused by negligence or wrongdoing (Klein and Pielke 2002). In general, most claims against the government based on weather forecasting or failing to issue weather warnings will likely be resolved in favor of the government due to discretionary and misrepresentation functions (Klein and Pielke 2002). This is because a task performed by a government employee, such as a meteorologist, involve permissible exercise of judgment by the employee, as they utilize caution for the exercise or performance, or even the failure to exercise or perform, a duty. Furthermore, to be tried under the misrepresentation function, a forecast must be grounded with the intent to deceit or interfere with one's ability to heed weather warnings. Given the intrinsic difficulty of a meteorologist's weather forecast, they are often protected by the discretionary and misrepresentation function because of the weather's inherent uncertainty. Even if immunity by either of these exceptions were unavailable, the government is unlikely to be found negligent simply because a weather forecast turns out to be wrong. For a case to be barred by immunity on the basis of the discretionary function, the conduct involved must be presumed that the individual's acts are grounded in policy when exercising the discretion (Klein and Pielke 2002). Furthermore, for a case to be barred by immunity under the misrepresentation exception, the plaintiff must show that inaccurate or inadequate forecasts were intentionally negligent (Klein and Pielke 2002).

One such example of a case barred by immunity under these circumstances is the Bartie v. United States court case following Hurricane Audrey (Klein and Pielke 2002). Here, Whitney Bartie asserted that the United States Weather Bureau, presently known as the National Weather Service (NWS), and several televised news broadcasts failed to provide proper and accurate warning on Hurricane Audrey and its effects the night before the storm made landfall (Klein and Pielke 2002). As a result, Bartie and his family, along with hundreds of others were awoken the following morning to find themselves experienced the full brunt of the storm and unable to evacuate (Klein and Pielke 2002). The Weather Bureau was then sued for negligence to provide adequate warnings concerning the nature, intensity, location, as well as the correct time Audrey would strike (Klein and Pielke 2002). The court ruled that, while the advisories themselves were adequate, they failed to convey the urgency of the situation; however, the Weather Bureau has no such duty to relay the urgency of weather advisories (Klein and Pielke 2002). Thus, the case was barred by the discretionary and misrepresentation exceptions, as weather warnings and advisories involve a great deal of judgment and discretion due to weather's unpredictable nature (Klein and Pielke 2002).

Klein and Pielke (2002) detail an additional case with similar conclusions. In the Chanon v. U.S. court case, two fishermen died when their shrimping vessel sank due to damage inflicted by severe storms (Klein and Pielke 2002). The men's estates sued the government for its forecasts, claiming that the Weather Service failed to disseminate weather information for broadcasting. While the court did find evidence that one warning was not broadcast on a station that the fishermen relied on, the court dismissed the case under the FTCA (Klein and Pielke 2002). The court concluded that the Weather Service was not negligent in the manner of assembling and delivering up-to-date severe weather warnings (Klein and Pielke 2002). Furthermore, the court determined that the Weather Service owed no duty to directly broadcast such information and was not responsible for ensuring television stations transmitted their information (Klein and Pielke 2002).

The preceding court case decisions indicate that the FTCA most often prevents claims against the government based on inaccurate or inadequate weather forecasts. However, in instances where all discretion is removed, the government's failure to follow mandatory regulation or policy could expose liability (Klein and Pielke 2002). Nevertheless, the case decisions imply that policy factors and the desire not to over warn enter into NWS forecasting and make warning decisions particularly difficult. Weather predictions, given its ability to change unexpectedly and inexplicably, should not then be considered as any evidence of fault on the part of the Weather Service (Klein and Pielke 2002).

Concerned with the ways that meteorological entities disseminate pertinent weather information, this section shows that even under circumstances where communication was inaccurate or inadequate, NWS forecast meteorologists are ultimately protected by the federal government on the basis that meteorologists may utilize their discretion for deciding when and how to report weather warnings. Although an explicit court case suing broadcast meteorologists has not yet been tested in court, these cases implicitly assert that broadcast meteorologists are important to the communication system, and that they should be tried separately when determining liability, especially if they fail to represent particular geographical groups within their designated market area (DMA). Furthermore, one could argue that broadcast meteorologists take on the same accountability as NWS meteorologists because they relay emergency information provided by the NWS. Yet, the government owes no such duty to ensuring adequate distribution of severe weather information throughout the entirety of a viewing market (e.g., DMA). The federal government, in its essence, only requires that the information covered is locally occurring. Furthermore, the court rulings demonstrate the importance of examining the media's role in providing fair and sufficient representations by various geographical groups.

While these cases do not explicitly distinguish the challenges DMAs may pose, they provide an underpinning for examining how broadcast meteorologists communicate severe weather information throughout a DMA in a geospatial context.

2.4. Severe Weather Warning Dissemination Techniques

Warning the public remains a difficult process, in part because the public is a largely diverse population with tremendous variation in education, physical abilities, family support, and situational awareness. To overcome these challenges, a variety of methods are used to disseminate information about severe weather warnings. One of the most common modalities broadcast meteorologists utilize to disseminate such information is through television, however, the modernization of technology now allows for broadcast meteorologists to further their geographical outreach by transmitting their messages online through social media platforms (e.g., Facebook Live, Twitter, etc.) and smartphone apps (Phan et al. 2018, Ebner 2013, Coleman et al. 2011). Additional outlets the public may rely on include information provided from NWS online (i.e., webpage and social media) or NOAA radios. Yet, television continues to be the leading source by which broadcast meteorologists disseminate warnings and the public receives warnings (Nunley and Sherman-Morris 2020, Reed and Senkbeil 2020, Pew Research Center 2019).

Previous research shows that most people receive weather information from more than one source, often relying on television as their primary source for receiving information and utilize online sources for confirmation (Nunley and Sherman-Morris 2020, Reed and Senkbeil 2020, Klockow-McClain et al. 2019, Pew Research Center 2019, Klockow et al. 2014). In general, Nunley and Sherman-Morris (2020) found that close to half of individuals (45.9%) prefer local television news, with the next two most preferred sources being Facebook (37%) and the

Weather Channel (35.3%) to receive weather information. Similarly, Reed and Senkbeil (2020) found local television news to be the most frequently checked source for receiving information (28%), with smartphone applications following closely behind (21%). At a national level, Pew Research Center (2019) found that 41% of individuals preferred receiving pertinent news information from local television stations over online sources. However, these numbers drastically increase for receiving information during an active severe weather event (Ripberger et al. 2019, NWS 2014, Klockow 2013).

Even in an age of readily available information, concern still exists that certain individuals are not receiving severe weather warnings. Of particular concern are individual's ability to get warning information from appropriate sources and their ability to understand the information contained within them. Some research has shown that linguistic, ethnic, and racial differences influence the extent to which people can receive and understand information conveyed in warning messages (Doyle 2016, Ahlborn et al. 2012, Burke et al. 2012, Donner et al. 2012, Senkbeil et al. 2012). For example, some studies have found that minority and native Spanish-speaking populations are less likely to receive critical information about severe weather than nonminority and native English-speaking populations (Doyle 2016, Ahlborn et al. 2012). Other research suggests that content within the warning itself significantly impacts an individual's ability to comprehend the warning (Ripberger et al. 2019, Drost et al. 2016, Joslyn and Savelli 2010). A broadcast meteorologist's televised coverage of severe weather events will further relay NWS-generated messages about weather warnings and watches. Messages from the NWS incorporate several key pieces of information, including the geographic area, time and duration, its path, text describing the potential hazards, and advice for protective action. These elements relate to geography and provide broadcast meteorologists with a setting for discussing severe weather risks as they unfold. By including such information, broadcast meteorologists are able to tailor messages to the people impacted for a particular place and time, and these people are more likely to understand messages about severe weather risks. There is little research, however, that examines the extent to which broadcast meteorologist's dissemination of warnings impact the ability for particular geographical groups to access and understand such information.

Some research demonstrates that local populations often develop profound psychological commitments to specific weather stations or broadcast meteorologists (Sherman-Morris 2005). This knowledge helps us understand why people turn to television during a severe weather outbreak. Therefore, while the type of information included in the warning and the way it is disseminated is critical, trust in the forecast and the broadcast meteorologist delivering the messages are equally important when internalizing the risk of harm and whether to take protective actions (Losee and Joslyn 2018, Ripberger et al. 2015, Trainor et al. 2015, Sherman-Morris 2005). Situations when a tornado warning is issued but never materializes is referred to as the false-alarm effect and are often associated with distrust in the forecast system and meteorologist as well as inadequate shelter-seeking behaviors. When there are too many false alarms, research has shown that over time people tend to disregard future warnings that are issued and associate their broadcast meteorologist with the cry-wolf effect (Ripberger et al. 2015, Trainor et al. 2015). Despite considerable interest in the weather enterprise to improve warning dissemination and accuracy, many people characterize these moments as dishonest or misguided by their local meteorologist, which creates problematic relationships between the public and weather informants (Ripberger et al. 2015, Trainor et al. 2015).

Specifically, Ripberger et al. (2015) investigates the impacts of forecast errors on perceptions by the public of the quality of the warnings and trust in the forecast system. The author's empirical findings are consistent with the false alarm logic, frequent false alarms and missed events appear to generate heightened levels of perceived inaccuracy, lower trust in the NWS, and lessened the likelihood of intended protective behaviors (Ripberger et al. 2015). However, these findings say little about the likelihood and relationship between intended and actual response to future tornado warnings. Trainor et al. (2015) also examines how false alarms interact with public trust and protective actions. First, the results indicate that people's perception of false alarm frequency did not significantly predict protective actions. Most importantly, however, Trainor et al. (2015) report evidence that many people characterize false alarms as dishonest or misguided by forecasters, which creates problematic relationships between the public and weather informants. These findings do provide one recommendation; to increase public trust and response to tornado warnings, the NWS could launch technical and social campaigns to recount the dramatic improvements in warning system accuracy that occurred over the past couple decades (Ripberger et al. 2015). Such actions may influence individual perceptions about tornado warning accuracy, thus increasing the likelihood of individual to take protective action when warnings are issued.

For warning alerts, past studies have shown that individuals have greater trust in their local broadcast meteorologist when their messages contain specific geographic details – such as references to nearby cities and landmarks, direction of travel, and the seriousness of the situation (Cario 2016, Coleman et al. 2011). Taken together, these elements construct a picture of risk associated with a severe weather outbreak and provide residents with specific information about when, where, and how they will be impacted. In this way, messages containing specific geographic details help broadcast meteorologist's disseminate consistent messages to affected communities. One recent study, for example, speculated that these elements were critical for effective risk communication because it allows a broadcast meteorologist to tailor information to their respective audiences at a local level, all of which drive the urgency and severity of severe weather risks as they unfold and assists viewers in distinguishing threats relative to their location. Additionally, the way local broadcast meteorologists warn their viewers of severe weather threats largely depends on their understanding of the local market, thus requiring continual refinement of delivery over time (Coleman et al. 2011). Because broadcast meteorologists operate in a specific region, or viewing market (e.g., DMA), they have a better overall understanding of their local community and can adjust the way they speak about weather risks to match their community's needs. Local viewing markets, therefore, define the way broadcast meteorologist's utilize geographic details to adjust their messages.

A broadcast meteorologist's usage of visual aids such as animated maps with warning polygons are useful to viewers in providing a snapshot of risk over an area of interest. The presence of warning displays creates a complex landscape from which the weather story must be told with accuracy and reliability within current forecast constraints. There are a number of studies that examine mapped representations of uncertainty information in weather warnings and how they influence public decision making. Nagele and Trainor (2012) use geography to propose that the presence of warning boundaries could alter protective action and decision making, but their study did not find any conclusive effects. The authors could not confirm if risk perception would change in a geospatial context, meaning, participants inside the warning polygon that is made distinct of being "at-risk" did not definitively differ from participants outside of the warning polygon, which is deemed not "at-risk" (Nagele and Trainor 2012). Nagele and Trainor (2012) did find evidence to support the notion that in events where the warning polygons were smaller than 50% of the county, participants were more likely to seek shelter. Additionally, research found that residents' proximities to tornadoes, in general, made a difference in engaging in protective action; if the tornado was more than five miles away, participants did not seek shelter as they were no longer directly under the storm (Nagele and Trainor 2012).

Klockow-McClain et al. (2019), however, found evidence for the existence of a boundary effect on subjective estimates of risk but the results were more complex than Nagele and Trainor (2012) revealed. Klockow-McClain et al. (2019) studied how different displays of possible experimental tornado warning information affected public response. The study presented a variety of representations of uncertainty information based on the precepts of cartography and information visualization, which included the length of the warning boundary, distance, and symbolic color coding (Klockow-McClain et al. 2019). The authors found evidence for the existence of each of the three proposed geospatial framing effects. First, results found that lengthening the tornado warning polygon not only increased subjective estimates of threat for people farther away from the storm, but also decreased the subjective perceptions for people who were close to the storm (Klockow-McClain 2019). Here, the results indicate that a trade-off might exist between alerting people further away from the storm earlier and maintaining a sense of urgency for those who are closest to the storm (Klockow-McClain et al. 2019). Next, results demonstrated that either cool colors or a decline from warm colors toward an absence of color decreased subjective estimates of risk (Klockow-McClain et al. 2019). The authors suggest avoiding the use of cool colors in tornado warning polygon depictions (Klockow-McClain et al. 2019). In the interest of promoting warning response, Klockow-McClain et al.'s (2019) findings allow researchers, forecast meteorologists, and broadcast meteorologists to estimate the impacts of warning polygon interpretation through modern dissemination tools, as warning messages are often tailored to televised broadcasts.

Complimenting Klockow-McClain et al.'s (2019) findings, Zhao et al. (2019) investigates public response to tornado warnings during a simulated scenario of the Moore, Oklahoma tornado that struck the city on 20 May 2013, both before and after exposure to televised media reporting. Limited research focuses on how public response might be influenced by media exposure, which is especially important given that maps of tornado warnings are the most communicated public product in severe weather broadcasts (Klockow-McClain et al. 2019); as well as the sheer popularity of television during severe weather events (Nunley and Sherman-Morris 2020, Reed and Senkbeil 2020, Pew Research Center 2019). Zhao et al.'s (2019) study involved presenting the May 20th tornado warnings through a series of escalating video news reports, media coverage of the disaster, as well as manipulation of both warning displays for the simulated event. The results confirmed that public perceptions of threat and protective actions were triggered by exposure to warning messages, and thus positive affect, negative affect, risk perception, and behavioral intention became heightened with escalating reports of weather severity (Zhao et al. 2019). In other words, the results may be generalized to suggest that people have higher levels of risk perception and are more likely to seek shelter after being exposed to media coverage of tornadoes, suggesting that the impact of media reporting of an actual natural disaster is quite substantial (Zhao et al. 2019). It is less clear, however, the effects of media exposure for communities who do not receive exposure to severe weather reporting. It is important to understand the influence of media exposure, or lack thereof, on public behavior and response to tornado warnings, especially if we are to improve communication and reduce overall vulnerability.

Understanding is the process of comprehending the meaning of severe weather warning messages (Drost et al. 2016). In television, weather warnings are typically conveyed through live radar, live coverage, and warning scrolls. However, these methods may not entirely be effective. Drost et al. (2016) compared the effectiveness of warning elements and delivery methods associated with how a tornado warning was presented in one of three formats: traditional, animated, and audio warnings to evaluate the impact of both attention to and memory of the warning. The traditional warning was simply a 95-second video broadcast; the animated warning included information contained in the traditional warning, but added representations of precautionary information, such as to avoid standing near windows and to seek shelter at lower ground. Lastly, the audio warning contained the initial narration from the traditional warning but with no visual aid. Results indicated that the animated warning was more effective than the traditional warning, as viewers of the animated warning retained more pertinent information about the hazard than those who viewed the traditional warning. Additionally, the animated warning significantly impacted viewer retention of severe weather information when compared to viewers of the traditional or audio warning. In summary, Drost et al.'s (2016) may be used to advance current severe weather warning communication techniques to increase public awareness and response as severe weather events unfold.

Implicit in much of this work are the ways people perceive tornado risk and their potential to incur harm from them. Individuals often take an interest in their local weather patterns and become familiar with their area by watching environmental cues (Peppler et al. 2018, Klockow et al. 2014, Silver 2014). Some past studies have indicated that using such environmental cues – going outside to look at the clouds, for example – assist in their personalization of tornado risk. Klockow et al. (2014) and Peppler et al. (2018) explore how people understand tornado risk in terms of location, which significantly impacts how people respond to tornado warning messages. Klockow et al. (2014) examined place-based perceptions of risk for individuals who experienced tornadoes in the 27 April 2011 tornado outbreak in Alabama and Mississippi. Individuals reported attending to physical and cultural features, such as rivers, hills, urban centers, and local cultural legends, to confirm how they perceived risk for their location (Klockow et al. 2014). Additionally, Peppler et al. (2018) found that residents in central Oklahoma relied on similar features and identified particular places as either risk-prone or risk avoidant. Here, residents expressed that clusters of buildings and places nearby rivers and hills were features that prevented tornado activity, whereas highways and low-lying open areas were features that attracted tornadoes (Peppler et al. 2018). Both Klockow et al. (2014) and Peppler et al. (2018) found that while most people received tornado warnings and understood the gravity of the situation, they carried them with conflicting notions about local tornado threats that influenced their perceptions of personal risk as tornadoes approached. Beyond the basics, these studies show that individuals can become confused or misled by myths or false information about tornado behavior, which potentially leads to unsafe responses.

In addition to people's general knowledge about tornadoes and their occurrence, research suggests that social amplification of risk through media reinforcement could contribute to the distorted perception of tornado hazards (Cario 2016, Ebner 2013). Certain drama laden narratives, however, coexist with a sense of dread for professional meteorologists because they understand that a problem must be dramatic and exciting for it to maintain public interest. Severe weather events capable of producing tornadoes is inherently a dramatic event with potential human-interest impacts. Broadcast meteorologists carry out various activities for amplifying drama to retain viewers engagement with their coverage, such as location reporting, replaying exciting footage, or using evocative words and images to illustrate the severity of risk (Cario 2016). It is, therefore, difficult to scrutinize the media for sensationalizing severe weather information as entertainment when lives of viewers are on the line. The drama surrounding a broadcast meteorologists' coverage of a tornado may truly reflect the gravity of the situation when lives are at stake, but viewers may attribute confusion between dramatized coverage and accurate reporting if an event were not to take place as anticipated, thus causing a "false-alarm" scenario (Cario 2016, Ripberger et al. 2015, Trainor et al. 2015). The potential consequences for sensationalizing risk messages during a tornado outbreak, of course, impacts viewers trust in the broadcaster when a forecast is inaccurate, or an event does not take place as it was communicated by the broadcaster.

Despite that meteorologists can sometimes be inaccurate in their weather predictions; viewers generally trust their local broadcaster and follow their advice during extreme weather (Sherman-Morris 2005). Concerns for false alarms following severe weather events pose serious challenges for meteorologists and explains why the public expresses frustration and lack of trust when events do not unfold as expected (Ripberger et al. 2015, Trainor et al. 2015). In this way, both televised media and online media messages act to personalize and potentially increase the local specificity of warning information, as well as make the information seem consistent.

Presently, the public has more options than ever before when it comes to receiving severe weather information, both locally and regionally. Broadcast meteorologists across all designated market areas (DMA) must therefore continually fine-tune their communication strategies to gain and retain viewers' as well as their trust. In a study of the connection between television meteorologists and their viewers during severe weather events, Ebner (2013) evaluates whether broadcast meteorologists can modify their delivery method to persuade viewers to seek shelter during an event. The goal of Ebner's (2013) research was to find new, improved and different ways that broadcast meteorologists could connect with their local viewing area during severe weather coverage. Following the 2011 tornado outbreak in Joplin, Missouri, Ebner (2013) surveyed viewers from Missouri's television markets (e.g., DMA's) to gain insight as to what viewers thought about their local broadcast meteorologist's severe weather coverage. In general, viewers expressed a desire for more detailed information about the storm and its trajectory, and preferred when broadcasters referenced specific place-names, such as cities, streets, and schools (Ebner 2013). In examining viewer's satisfaction with their local severe weather coverage, viewers believed rural communities did not receive the same attention or quality of coverage than urban communities nearby, and that their local meteorologist often switched to social media platforms after the storm passed the urban center (Ebner 2013). In this area, rural residents were found to be 30% less likely to hear tornado sirens at their place of residence and 4% less likely to have access to mobile devices. Viewers are, therefore, more likely to rely on television as a means for receiving up-to-date information about severe weather risks as they unfold. Research suggests broadcast meteorologists to continue televised broadcasts until the threat is over, even if storms are further away from urban cores.

Local television news may not outwardly confess to emphasizing certain geographies during their severe weather coverage. However, a later study reported similar findings. Cario (2016) examined risk communication for local television stations following the 2010 tornado outbreak in Oklahoma City, Oklahoma, in which the author analyzed recorded broadcasts for two local television stations in Oklahoma City's DMA: ABC-affiliate KOCO-5 and CBS-affiliate KWTV-9. Results found a noticeable shift in both the quality and geographic focus of coverage. As storms moved out of the Oklahoma City metropolitan and east towards rural populations, in-depth wall-to-wall coverage led by the meteorologist faded back to traditional news structure where anchors drove the broadcast with support from reporters (Cario 2016). This shift poses serious consequences for those residing on the fringe of the television market. While storms remained active in fringe territories, broadcasts opted for narratives focused on damage and human-interest stories rather than the same type of risk communication seen earlier in the broadcast when the storm was around more urban and populated areas of Oklahoma City (Cario 2016). Since local populations often develop strong bonds and trust with their broadcast meteorologist (Sherman-Morris 2005), the noticeable shift in framing in coverage may perpetuate misconceptions and interpretations surrounding the severity of the event and need for appropriate shelter-seeking behaviors. Broadcast meteorologists have the power to reinforce their messages through the structure and presentation of information in their broadcast. Moreover, this process elicits support of disproportionate levels of severe weather coverage across the DMA. Those in less populated rural areas located further away from the city center do not receive the same level of information and coverage during a severe weather event, which has a direct effect on the ability for people in these areas to take protective action (Cario 2016). In this way, both Ebner (2013) and Cario (2016) show that a better understanding of risk communication in television and how broadcast meteorologists meet the needs of those most at risk will substantially help prevent and mitigate disaster.

2.5. Perceptions About Severe Weather Communication Among Meteorologists

Finally, few studies consider perspectives from meteorological personnel, including forecast meteorologists and broadcast meteorologists, about their severe weather warning communication and how it impacts public response. These studies, however, provide rich insights into why portions of the public do not receive adequate warning coverage, their understanding and use of warnings, and their reasons behind not seeking shelter upon receiving a warning. In a recent study by Sherman-Morris et al. (2018), researchers surveyed Warning Coordination

Meteorologist's (WCM's) to determine what social science-related research would be most beneficial for them in communicating with their audiences. A prominent theme found from participant responses related the need for a better understanding of what the public wants and how they use and understand NWS products (Sherman-Morris et al. 2018). The limited perceived knowledge of the public expressed by WCMs, however, contrasted with their perceptions of the media. WCMs claimed that their outreach activities tended to be more concentrated on the media than on the public (Sherman-Morris et al. 2018). They recognized the importance of broadcast meteorologists in translating warning information but voiced that this information would only encourage precautionary action if the information was assimilated into one's belief system (Sherman-Morris et al. 2018). Therefore, the media may translate information contained in NWS products into dramatic narratives in order to attract viewers and obtain higher ratings. Other research confirms that these translations significantly affect the public's ability to comprehend warning information (Doyle 2016, Ahlborn et al. 2012, Burke et al. 2012, Donner et al. 2012, Senkbeil et al. 2012), which result in the publics misunderstanding of the severity of a weather hazard (Cario 2016, Ebner 2013).

In researching perceptions among NWS personnel, one can compare them with insights from the public to identify potential disparities between the two. Walters et al. (2020) explores the perceptions of NWS personnel regarding the public's behavioral response to tornado warnings, factors that might influence public response, and how their own perception of the public's response impact NWS warning communication. First, a common perception found among NWS personnel was that the public's access to and understanding of NWS warnings varied by location. Forecasters tended to express concern about urban residents being less likely to heed weather warnings than rural residents and suggested that rural residents need more attention due to lack of quality resources (Walters et al. 2020). Warning communication in these areas face significant barriers, however, such as poor cell phone reception and lack of Internet or television signal due to rurality. While forecasters did not provide suggestions for these barriers, they did voice a desire for more specific information in warnings to be based on their location (Walters et al. 2020). This desire is consistent to that of Ebner's (2013) findings. Additionally, forecasters spoke positively about the public's ability to understand warnings but believed that the public may not personalize the risk until confirming the threat with multiple sources, such as television or standing outside (Walters et al. 2020). Prior research on receiver knowledge and understanding of tornadoes also confirms this (Peppler et al. 2018, Klockow et al. 2014, Silver 2014). Lastly, most forecasters believe that television reports provide more detailed and precise descriptions of unfolding tornado threats, and even positively mentioned their local broadcaster by name – indicating trust in their reports, which is congruent with Sherman-Morris' (2005) findings. In geographic areas where access to television broadcasts may be an issue, Walters et al. (2020) also recommend encouraging local meteorologists to provide regular online engagement and warning as far in advance as possible to help residents prepare. Prior research, however, cautions warning residents further downstream of storms, as apparent tradeoffs exist between alerting sooner and maintain urgency (Klockow-McClain et al. 2019).

Previous research extensively examines the effects of cartographic warning displays on public response (Klockow-McClain et al. 2019, Zhao et al. 2019, Drost et al. 2016, Nagele and Trainor 2012). However, the perception and comprehension of forecast graphics produced by television has been largely overlooked. Thus, the purpose of Reed and Senkbeil's (2020) study expanded upon preceding knowledge by examining broadcast meteorologist directly, questioning their opinions about their use of forecast displays and their thoughts about the public's ability to utilize and understand the information. Their results showed an apparent disconnect between broadcast meteorologists and their viewers. Not a single broadcast meteorologist felt confident that their audience viewed the entirety of their stations televised weather segment, perhaps because of the increasing prevalence of technological sources. Phan et al. (2018) found similar results; among weather app users, Phan et al.'s (2018) study revealed that video forecasts were ranked as generally not important, which confirms the notion that important weather graphics should be able to stand alone, regardless of where and how they are presented. As information continues to be consumed over different modalities, in addition to television, more work is needed to validate the effectiveness of individual weather graphics.

Research on the perceptions of meteorological personnel and the public primarily critique severe weather warning communication through warning displays themselves. Many of these studies detail the media's importance during severe weather events, recognizing television as an intermediary between forecasters and the public, but less attention focuses on the insights and perceptions among broadcast meteorologists during their live coverage of severe weather events. Demuth et al.'s (2009) case study on broadcast meteorologists attempted to identify how they chose topics as being relevant or important in their live presentations of severe weather. Most importantly, the authors' found that broadcasters vary in their perceptions of what their audiences want, need, and can understand (Demuth et al. 2009). Generally, broadcasters felt confident in their audience's ability to understand their coverage and spoke highly about their warning efforts with NWS meteorologists. This is contrary to studies like Walters et al. (2020) and Reed and Senkbeil (2020). Additionally, broadcasters expressed facing challenges in their ability to communicate uncertainty in severe weather forecasts due to competing demands for time on air from other aspects of advertisers and news topics (Demuth et al. 2009). Given that broadcasters are sensitive to competing actors, such as broadcasters at other television stations within the same DMA, their coverage may vary in content selection to make up for what other competing broadcasters are not covering. Perhaps this provides reason to the inconsistent levels of coverage found in Cario's (2016) and Ebner's (2013) work. While these findings certainly contribute toward exploring the role and perspective of broadcast meteorologists, they remain inconsistent and therefore may not be conclusive or generalizable. Nevertheless, work in this field serve as groundwork for future studies to build upon.

2.6. *Theoretical Contributions to Geographical Studies of Media and Communication*

This review of literature presents an avenue for examining how various geographical viewpoints shape the dissemination of severe weather information as it is presented through televised media. One subset of literature, known as media geography, explores practices and processes by which geographical information is gathered, ordered, and presented in the media, and vice versa, how geographical patterns and processes shape the way information is transmitted through the media (Adams and Jansson 2012, Adams 2010). Geographer Paul Adams (2010) studies how various forms of media can be applied to representations of space/place relationships and suggests that there are four distinct and complimentary ways in which media and communication are inherently geographical, which he organizes and presents in a quadrant diagram (Figure 6). In this diagram, Adams (2010) proposes that communication is more than merely the process of transmitting messages; rather, communication is a spatially produced process (Adams 2010). To briefly summarize, Adams (2010) diagram comprises four elements that compliment space/place-based perspectives: (1) *places-in-media* signifies the representations of places as they circulate through the media, (2) *media-in-places* implies the way places inflect opportunities or limitations for individuals to receive information via the media, (3) *media-in-*

spaces represents the geographical arrangements, including cartographic illustrations, of information for multiple locations as it is presented in media, and (4) *spaces-in-media*, indicates the way media diffuses images, information, and ideas to various audiences (Adams and Jansson 2012, Adams 2010).

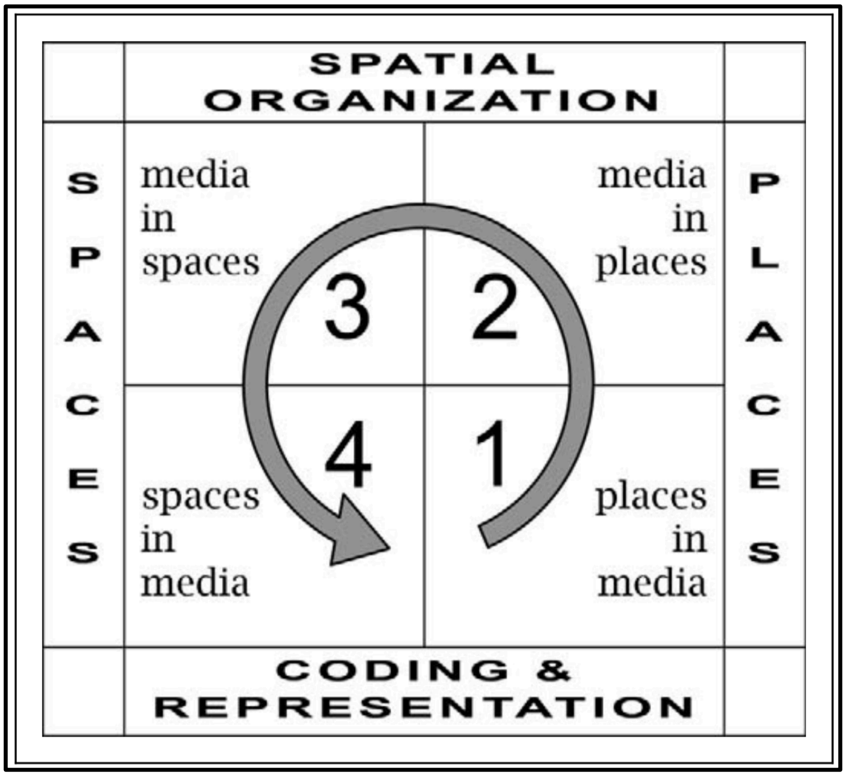

Figure 6. The quadrant diagram demonstrated in Adams (2010) paper, illustrating geographical flows of communication via space/place frames.

An examination of Adams (2010) four-quadrant diagram (Figure 6) unquestionably applies television media and the work presented throughout this thesis. Specifically, this thesis resonates well with aspects from Adams (2010) *places-in-media* quadrant, as it provides implicit inferences about potential systematic issues that arise when tasked with adequately representing rural and urban places during televised coverage of severe weather events. Much previous work centralized around a broadcast meteorologist's televised severe weather coverage indirectly suggests that perceptions of place effects the allocation of time and resources to covering storms for particular locals (Walters et al. 2020, Cario 2016, Ebner 2013). Specifically, research finds that their understandings about the ways urban and rural communities receive, understand, and respond to televised presentations of severe weather information impact the ways they discuss severe weather threats as an event unfolds (Walters et al. 2020, Cario 2016). Thus, the representation of places in televised media during a severe weather event is largely dependent upon a broadcast meteorologists' perception of places within their viewing market. Otherwise known as their local knowledge, this is understood to be a social product that helps people make sense of their surroundings, something that is culturally and geographically situated (Wagner 2007). Local knowledge can be grounded in fact, but more often it is based on anecdotal information that is shared throughout a population. This concept is particularly relevant because it helps explain why broadcast meteorologists may emphasize particular geographical locals during their televised coverage of severe weather events.

Our investigation into the multifaceted intersection between perceptions of place and televised communication is underpinned by numerous works especially Tim Cresswell (2015), Edward Relph (1976), and Yi-Fu Tuan (1975). Relph (1976) explains that deep emotional feelings to places can sway one's decisions, influence actions, and shape perspectives. Presently, images of space and place regularly appear as content of media, and every message follows a particular spatial route as it transcends from the sender (e.g., broadcast meteorologist) to the viewer (Adams and Jansson 2012, Adams 2010). When local broadcast meteorologists use specific geographical references such as streets and nearby landmarks to frame where the ongoing tornado risk is taking place, it influences how viewers perceive risk. Moreover, the way broadcast meteorologists understand these places can influence their decisions to provide televised coverage and actions taken to discuss elements of the storm to those at risk. By understanding how local knowledge is formed, this thesis can work to counteract misperceptions and misinformation that broadcast meteorologists have about the local communities they serve.

2.7. Summary and Significance to Thesis

Several areas of literature provide valuable context for considering the influence of broadcast meteorologists perceptions of space and place relative to their designated market area (DMA) when constructing their severe weather coverage. First, literature in policy stipulations outlined by the Federal Communications Commission (FCC) provide a framework for understanding how television market operations within a particular designated market area (DMA) affect the construction and provision of broadcast meteorologists televised severe weather coverage (Federal Communications Commission 2020, Scherer 2018, Smith 2009). Under the FCC's three rules – localism, diversity, and competition – broadcast meteorologists must find unique and creative ways for retaining viewers, such as the use of evocative rhetoric (Cario 2016, Ebner 2013, Demuth et al. 2009) and graphical packages to assist in spatially conveying risk information (Klockow-McClain et al. 2019, Zhao et al. 2019, Drost et al. 2016, Nagele and Trainor 2012), all of which may impact the geographic scope of their coverage and viewers ability to comprehend their messages (Ripberger et al. 2019, Drost et al. 2016, Joslyn and Savelli 2010). Current FCC policy encourages competition between stations and allows individual broadcast meteorologists to choose how they select content to include in their coverage, which also permits broadcasters to emphasize particular geographic locals. The influence of federally mandated policies on a broadcast meteorologists' capability to provide severe weather coverage throughout the entirety of their DMA, however, are overlooked in present research; this thesis will address this gap.

In addition, the FCC does not specify the nature of a broadcast meteorologist's spatial understanding for severe weather hazards, which can involve their attachments to specific places, cognitive representations of the local environment, and perceived relationships between local environments and severe weather hazards (Cresswell 2015, Wagner 2007, Relph 1976, Tuan 1975); these factors could shape the expectations broadcast meteorologists have about geographic locals within their DMA and shape the way they communicating severe weather threats to these places.

Additionally, studies examining mapped representations of hazard risks and cartographic cognition reveal that the presentation and exposure to mapped information significantly influence viewers likelihood of responding and seeking protective action (Klockow-McClain et al. 2019, Zhao et al. 2019, Drost et al. 2016, Nagele and Trainor 2012). Given that broadcast meteorologists stand at the forefront of risk communication during severe weather events and are responsible for communicating geospatial aspects of risk, it is crucial to know how broadcast meteorologists' interpretations of mapped spaces inflect the way the provide coverage to places throughout their DMA. For broadcast meteorologists, these a priori understanding of places throughout their viewing market with respect to improving risk communication remain unknown. Only few studies take into account the perceptions among broadcast meteorologists and make cursory inferences about their geospatial conjectures (Walters et al. 2020, Sherman-Morris et al. 2018, Cario 2016, Ebner 2013, Demuth et al. 2009).

This thesis will fill the gap in extant literature by providing a more explicit analysis of factors impacting a broadcast meteorologists decision to provide severe weather coverage, specifically by studying how their own perceptions of space and place relative to their designated market area influence the geographic focus of their coverage throughout an event. This work contributes to prior research by providing a fundamentally different approach, which is to show where broadcast meteorologists focus their attention geographically, and why, through a direct examination of their interpretations and opinions about their decision-making processes. The aforementioned literature review confirms that geography is a lingering power in how the broadcast sector communicates severe weather risks. Furthering previous work, this thesis examines how well broadcasters understand their designated market area (DMA), the procedures they follow for deciding when to provide and discontinue their live, on-air severe weather coverage, and their perceptions of how well their viewers understand and respond to messages within their weather coverage.

The results from this thesis can be found in Chapter 3, along with a summary of the implications of these findings in Chapter 4.

CHAPTER 3

To Be Submitted to *Weather and Forecasting*

Designated Market Areas (DMAs) and Severe Weather Coverage: Oklahoma-Based Broadcast Meteorologists and Their Decisions for Providing Televised Coverage of Severe Storms

Abstract

After the devastating severe weather outbreak in Oklahoma and surrounding states on 20-22 May 2019, it seemed appropriate to study the way broadcast meteorologists communicate severe weather risks to various communities, as there appeared to be a noticeable break in traditional televised coverage. This paper examines where broadcast meteorologists focus their attention geographically, and why, specifically by analyzing how they utilize their designated market area (DMA) to provide adequate and consistent reporting to specific communities within their DMA. Broadcast meteorologists (n = 20) across the State of Oklahoma were surveyed about their decision-making processes and perceptions of their DMA, and this was compared to actual 2017-2018 DMA regions. A qualitative GIS-based methodology was then used to produce a thematic analysis containing cartographic illustrations showing broadcast meteorologists' spatial knowledge. Results found that broadcast meteorologists have varying discernments of the places within their DMA and that they delineate specific geographical areas as focal points during their live severe weather coverage. Additional factors were influential, such as their beliefs about their viewer's weather knowledge and geographical awareness. Lastly, their decision to provide televised coverage relied considerably upon their perception of the storm's intensity and trajectory within the DMA, the populations that may be affected, and the programming on-air at the time. By understanding geospatial relationships among broadcast meteorologist's, this research provides scientific basis for improved communication efforts both before and during severe weather events, and for identifying potentially vulnerable populations.

Keywords: *Designated Market Areas (DMAs); Geographic Information Science (GIS); Qualitative GIS; Broadcast Meteorology; Risk Communication; Geographic Literacy; Oklahoma*

3.1. Introduction

Taking the lives of 24 people and injuring nearly 200 more, the EF5 tornado that struck Moore, Oklahoma, on 20 May 2013 is a grim reminder of the mass destruction that severe storms can cause (NWS 2014). Unfortunately, devastating tornadoes are prevalent in Oklahoma, as the state averages 57 tornadoes per year, which makes its residents no stranger to dangerous tornado outbreaks (NWS 2020, NWS 2019). Specifically, the state suffered from the most tornadoes on its record in 2019, totaling 149 events that ranged from EF0 to EF3 (NWS 2020, NWS 2019). Because of the prevalence of these hazards, local broadcast meteorologists must maintain a high public profile and provide severe weather coverage that safely guides their viewers through the most volatile storms. Likewise, local viewers become accustomed to their local broadcast meteorologists and find themselves turning to their live coverage each year to obtain up-to-date information as severe weather unfolds.

When springtime rolled around for Oklahomans in 2019, many expected traditional convective storms with potential for tornadic activity. In May 2019, however, meteorologists at the Storm Prediction Center (SPC) in Norman, Oklahoma, forecasted a series of high- and moderate-risk convective outlooks for severe weather capable of producing numerous devastating, long-tracked tornadoes similar to the tornado outbreak that took place for portions of the state in 2013 (NOAA 2019). Local broadcast meteorologists spent ample time in the weeks prior communicating the severity of the potential threat and urged residents to remain on high alert and prepare for the event ahead of time. The event’s ominous timing came on the sixth anniversary of the 2013 EF5 tornado, and on 20-22 May 2019, 59 tornadoes swept through the region, causing substantial property damage but fortunately no injuries or fatalities (NOAA 2019).

As tornadoes passed through Oklahoma, local broadcast meteorologists' team of storm chasers traveled across the state to capture live footage of tornadoes touching down in largely rural areas and open farmlands. National media was also quick to descend on the scene and later wrote headlines about the storms' impact, particularly noting that the expected dangerous outbreak did not take place as expected (Halverson 2019, Henson 2019). Yet, as tornado warning polygons continued to illuminate radar shown on many resident's home television screens that afternoon, the word "bust" crept into the community's narrative because the projected outbreak of catastrophic tornadoes like the EF5 in 2013 never materialized. Residents then turned their conversations to expressing frustration in their local broadcast meteorologist for hyping the seemingly uneventful event.

Local broadcast meteorologists focus thenceforth concentrated on the mysterious forecast "bust" despite continued storm activity impacting towns in the state. Besides broadcast meteorologist's original decision to provide continuous, live, wall-to-wall tornado coverage at the onset of the outbreak, a major shift in focus occurred as storms stagnated. Being a participant and viewer of this outbreak, the authors noticed that broadcast meteorologists spent considerable time communicating warnings as storms impacted western Oklahoma and approached the Oklahoma City metropolitan area. However, as these storms moved east out of the Oklahoma City metro, broadcast meteorologists faded from news coverage along with their in-depth reporting tailored towards communicating warnings. The news coverage following the shift revolved around human interest narratives and damage reports from the storm even as severe weather with active tornado warnings persisted for rural communities just outside of the city. Even when the storms approached Tulsa's metropolitan area, the authors noticed many Oklahoma City-based storm chasers capturing footage of tornadoes while few Tulsa-based broadcast meteorologists began providing continuous wall-to-wall coverage. Instead, many Tulsa broadcast meteorologists continued with their regular programming.

It is worth noting that the majority of tornado warnings that were issued took place along the boundary of Oklahoma City's and Tulsa's designated market area (DMA) (i.e., viewing market), which coincides with the local broadcast meteorologists' noticeable shifts in coverage. Broadcast meteorologists utilize their DMA to guide their severe weather coverage, as it provides a measurable geographical area containing counties where residents receive the same local television station. This shift, or break, in traditional storm coverage poses serious consequences for those residing on the margins of urban towns and in between two DMAs, such as communities in between Oklahoma City and Tulsa. The 20-22 May 2019 tornado outbreak shows that there is a disproportionate level of severe weather coverage across the state and suggests that those in less populated and rural areas located away from large cities do not receive the same level of time and attention spent towards communicating warnings during a tornado outbreak.

The tendency for broadcast meteorologists to inadequately represent particular places in their DMA is, unfortunately, a recurring theme nationwide. Prior research on local broadcast meteorologists and their live severe weather coverage also find that they have a propensity to shift geographic focus or discontinue their live coverage as storms move past large population centers and continue to affect nearby smaller areas (Cario 2016, Ebner 2013). Additionally, research shows that broadcast meteorologists have varied knowledge about the types of communities they provide coverage to and express differing concerns for urban and rural residents' ability to receive, understand, and respond to warning information (Walters et al. 2020, Demuth et al. 2009). Such challenges in broadcast meteorologists' understanding of their

DMA’s geographical and demographic diversity, therefore, significantly affects how they tailor severe weather messages to match specific community needs.

Outside of the way local broadcast meteorologists utilize their interpretations of places to determine how they structure severe weather coverage, there are also federal guidelines in place that implicitly control their decisions. Local broadcast meteorologists are keen on severe weather coverage and utilize the Federal Communications Commission (FCC) three media ownership rules – localism, competition, and diversity – to their advantage (Scherer 2018). Broadcast meteorologists recognize that FCC requirements can increase their television stations’ ratings, making them the preferred source for local viewers to receive real-time information about severe weather warnings. Surprisingly, however, there is little to no regulation outlined by the FCC that determines how a local broadcast meteorologist retains its viewers, which enables broadcast meteorologists to utilize their subjective judgments when deciding how they disseminate warning information to particular places. The FCC’s only fundamental requirement is that broadcast meteorologists disseminate messages that pertain to the local communities they serve (Federal Communications Commission 2020, Scherer 2018), meaning they circulate warning information affecting the communities within their designated market area (DMA).

Nevertheless, the vagueness of the FCC’s guideline, unfortunately, leaves room for disparities in broadcast meteorologists’ coverage of severe weather events. After witnessing many Oklahoma-based broadcast meteorologists discontinuing their live, continuous wall-to-wall coverage of severe storms despite continued storm acting within their DMA, it became increasingly clear that there are significant barriers that prevent broadcast meteorologists from fully engaging with the entirety of their DMA during a severe weather event. For this reason, it is important to understand where broadcast meteorologists focus their attention geographically, and why.

While broadcast meteorologists utilize their designated market area (DMA) to guide their severe weather coverage, this paper hypothesizes that a combination of factors exist that impact their decision to provide adequate and consistent reporting throughout the entirety of their DMA. Specifically, we expect that these factors include their subjective interpretations of space relative to their DMA, such as their recollections of the geographic extent and breadth of counties included within their DMA region, and their perceptions of places within their DMA, such as where they believe most of their viewers reside in the market and their opinions about what their viewers know and understand. As a consequence of these interpretations, there are times when some places receive inadequate and inconsistent severe weather coverage. This study, therefore, provides insight into how the present dynamic between broadcast meteorologists' perceptions of space and place relative to their DMA compel risk communication geographically.

In this endeavor, this paper takes a unique approach by understanding how broadcast meteorologists in the State of Oklahoma make decisions surrounding when to provide or discontinue live, continuous wall-to-wall coverage, specifically through examining their perceptions in a spatial context. This study, therefore, pinpoints discrepancies in mapped spaces relative to broadcast meteorologists assigned DMA boundary and identifies opportunities to improve their messaging techniques, as they are responsible for delivering hazardous warning information for storms affecting those in their DMA.

3.2. Background: Severe Weather Communication in Local Television News

Broadcast meteorologists serve a critical and complex role in the communication of severe weather warnings. Research conducted following tornado outbreaks indicates that the majority of residents receive severe weather warnings from their local broadcast meteorologist (Phan et al. 2018, Schmidlin et al. 2009, Sherman-Morris 2005, Hammer and Schmidlin 2002) and even cite trust in their broadcast meteorologist's advice as being an influencer in their decision to take protective action (Losee and Joslyn 2018, Nix-Crawford 2017, Ripberger et al. 2015, Trainor et al. 2015, Sherman-Morris 2005, Hammer and Schmidlin 2002). Amidst multiple technological sources and the increasing prevalence of online platforms becoming popular ways for the public to receive warning information, research continues to indicate that television remains the primary source for receiving tornado warning information nationwide (Nunley and Sherman-Morris 2020, Phan et al. 2018, Reed and Senkbeil 2020, Mitchell et al. 2019, Silva et al. 2017).

Given televisions sheer popularity, studies on broadcast meteorologist's televised communication during a severe weather event generally fall into three categories – those that focus on agency communication (Federal Communications Commission 2020, Scherer 2018 Smith 2009, Yan and Park 2009), those that focus on tools used in on-air coverage (Phan et al. 2018, Wei et al. 2010, Daniels and Loggins 2007), and studies that incorporate some investigation of media exposure as part of a broader aim (Zhao et al. 2019, Klockow-McClain et al. 2019, Drost et al. 2016, Nagele and Trainor 2012). Apart from this, only a small number have investigated perceptions about communicating severe weather information among broadcast meteorologists directly (Reed and Senkbeil 2020, Walters et al. 2020, Sherman-Morris et al. 2018, Cario 2016, Ebner 2013, Demuth et al. 2009). Only two studies have touched on how broadcast meteorologists make decisions about when they provide live, continuous wall-to-wall severe weather coverage (Cario 2016, Ebner 2013); neither study focused on where they concentrated their coverage geographically, and only one considered a boundary-effect resulting from the presence of designated market area (DMA) regions (Cario 2016).

Broadcast meteorologists readily draw upon their understanding of geography, particularly their interpretations of space and place, to assist in disseminating severe weather warnings. Investigations into the multifaceted intersection between one's perception of space and place and televised warning communication are underpinned by numerous works, especially by Tim Cresswell (2015), Edward Relph (1976), and Yi-Fu Tuan (1975). These geographers propose that people develop specific attitudes and feelings about a place with regard to the geographical areas in which they live. Specifically, Relph (1976) and Tuan (1975) explain that one's deep emotional feelings to place can sway their decisions, influence actions, and shape their perspectives. Therefore, broadcast meteorologists' geospatial relationships, such as their understanding of inherently spatial DMA boundaries and interactions with the places within them, influence their decisions to provide coverage and the locales they choose to include in their coverage. However, the ways in which their spatial cognizance affect how they communicate weather information to various places remains an under-investigated area, yet one that may yield practical insight into how to best improve their communicative outreach.

In perhaps the most relevant example of potential spatial cognitive barriers impacting how broadcast meteorologists disseminate severe weather information is their familiarity and utilization of designated market areas (DMAs). The Federal Communications Commission (FCC) works with The Nielsen Company to determine DMA boundaries by measuring exclusive geographic areas that outline counties receiving the same television station coverage (Scherer 2018). These boundaries provide broadcast meteorologists with a geographical representation of their viewing audience, which contain diverse populations of varying viewpoints and backgrounds. Additionally, the FCC ensures local broadcast meteorologists disseminate information that matches public needs and interests by enforcing localism, which is a policy that requires television stations to report information that directly pertains to the communities encompassing their DMA boundary (Scherer 2018).

While there is no prior research that specifically examines how ones' familiarity with a DMA influences the way coverage is provided throughout a region, there is some research to suggest that the presence of FCC's localism policy significantly affects the way particular communities within a DMA are represented. For example, Smith (2009) and Yan and Park (2009) examine how localism affects the diversity of content, meaning, the types of information included in news coverage, as well as the time allocated to covering certain information. These studies find that locally produced news coverage that is geographically focused to the DMA is heavily influenced by competing forces, such as decisions made by competitor stations that are within the same market. Therefore, the quality of coverage can vary considerably between neighboring stations and impact how a broadcast meteorologist deems the information as being necessary and important to include in their coverage. This, too, subliminally affects the types of communities that receive quality news coverage as certain communities will receive more attention than others.

The vagueness of FCCs localism rule offers broadcast meteorologists a great deal of flexibility when determining the geographic scope of their coverage because they do not control the selection or presentation of content included within a televised broadcast. Current FCC rulings, however, do require that broadcast meteorologists make certain emergency information accessible, in English, to persons who are deaf or hard of hearing and to persons who are blind or have visual disabilities (Federal Communications Commission 2020). Yet, when determining whether particular details need to be presented visually or aurally, the FCC allows broadcast meteorologists to rely on their own discretion (Federal Communications Commission 2020).

Typically, broadcast meteorologists disseminate warnings through preemptive cut-ins where the meteorologist either directly interrupts television to provide specific information about the warning or provides a full-screen Emergency Alert System (EAS) graphic with audio indicating the warning is in effect (Coleman et al. 2011). They may also utilize screen "crawls" or "bugs" to provide updates without interrupting regular programming, which is usually placed at the bottom corner of the television screen as a stream of text (e.g., "crawl") or as a map of the television station's viewing area highlighting counties under warning (e.g., "bug") (Coleman et al. 2011). Nevertheless, there is no federal law that requires a broadcast meteorologist to provide extensive, wall-to-wall coverage of severe weather warnings, which ensues variability in the quality of severe weather coverage as a broadcast meteorologist can determine how they present and communicate particular aspects of a storm to their respective DMA.

An additional factor influencing the quality of coverage for particular places stems from the ways in which broadcast meteorologists compete for viewers' attention. Warning information should reach every person who is in danger and needs to be presented in a timely fashion (Wei et al. 2010). Therefore, broadcast meteorologists must find creative ways to retain their viewers and provide them with have enough time to heed a warning. Daniels and Loggins (2007), for example, studied the visual tools broadcast meteorologists use to communicate weather threats and found that residents in disaster-prone regions were more likely to understand specific warning information with repeated exposure to warning messages and when there is an increasing potential for the hazard to strike a specific geographical area. Other research finds that meteorologists convey the urgency of warnings through the use of evocative rhetoric and images, replaying exciting footage, or recounting harrowing moments from storms that persisted earlier in the outbreak (Cario 2016). These elements not only entice viewer attention, they also increase the public's exposure to critical information and encourage viewers to remain alert throughout the entirety of an event.

Moreover, few studies discuss how disseminating warning messages through various communication mediums affect the way particular geographical groups receive and understand such information. Many factors related to one's ability to receive warning information arise from demographic and sociological characteristics. For example, some past studies have found that men do not heed warnings as closely as women (Sherman-Morris 2010, Silver and Andrey 2014), though one study found no association with gender and response (Nagele and Trainor 2012). Other studies found that age, too, has mixed results, but generally impacts how likely one receives and responds to weather warnings (Senkbeil et al. 2012). Additional factors, such as linguistic, ethnic, and racial differences, can also significantly influence the extent to which people can receive and understand the information conveyed in warning messages (Doyle 2016, Ahlborn et al. 2012, Burke et al. 2012, Donner et al. 2012, Senkbeil et al. 2012). For example, some studies have found that minority and native Spanish-speaking populations are less likely to receive critical information about severe weather than nonminority and native English-speaking populations (Doyle 2016, Ahlborn et al. 2012). Conspicuously, the FCC only requires television stations to transmit messages in English (Federal Communications Commission 2020). Educational attainment and income, too, are probable indicators of one's preparedness and likelihood to receive and heed warnings (Senkbeil et al. 2012).

Other research suggests that content within the warning itself significantly influences how different places comprehend warning messages (Klockow-McClain et al. 2019, Drost et al. 2016, Joslyn and Savelli 2010). Specifically, research in this area suggests the ways in which warning displays are communicated geographically affect viewer's ability to understand and respond to tornado warning messages. Broadcast meteorologists will incorporate key pieces of information, including the geographic area, time and duration, its path, and advice for protective action to those at risk. These elements relate to geography and provide viewers with a sense of understanding about the storm's severity and when it will impact their particular place. In this way, prior research has shown that one's physical proximity to tornado threat makes a difference in engaging in protective action; specifically, Nagele and Trainor (2012) found that if the tornado was more than five miles away, residents did not take cover. Generally, however, individuals tend to have higher perceptions of risk and greater behavioral intentions following exposure to various warning messages in a broadcast meteorologist's live severe weather coverage. Zhao et al. (2019), for example, confirmed that the public's risk perception increased following televised media exposure of the EF-5 tornado that struck Moore, Oklahoma in 2013. Therefore, televised coverage can increase one's perception of risk for individuals that lack personal experience with tornadoes.

Outside of this work, a considerable amount of research has examined perceptions among broadcast meteorologists as it relates to how they disseminate warning information and their thoughts about how certain places receive and respond to their live severe weather coverage (Reed and Senkbeil 2020, Walters et al. 2020, Sherman-Morris et al. 2018, Cario 2016, Ebner 2013, Demuth et al. 2009). Each of these studies find that broadcast meteorologists express an overall concern for urban and rural residents' ability to receive and respond to tornado warnings. For example, Walters et al. (2020) found that warning coordination meteorologists (WCMs) believed urban residents were, generally, less likely to follow severe weather events or heed warnings than rural residents but believed urban residents had greater quality access to information sources than those in rural places. Meteorologists feared that rural residents had a more challenging time accessing information due to a lack of access to resources like the Internet, Wi-Fi, and television signals. They suggested that rural residents were a segment of the population that needed more time and attention.

Research in this area has also shown that broadcast meteorologists decide when and how to provide severe weather coverage based on their understanding of particular places within their viewing market. Specifically, Ebner (2013) found that broadcast meteorologists discontinued their live televised severe weather coverage as storms exited large cities and instead provided coverage on social media platforms like Facebook Live as storms affected nearby rural towns. Furthermore, Cario (2016) found that broadcast meteorologists focused on communicating weather warnings for urban communities central to the DMA and excluded rural areas along the market's edge. These studies find evidence to suggest that some places, particularly those that are rural and less populous, receive disproportionate levels of coverage during severe weather events. In both studies, live, continuous wall-to-wall coverage centralized around tornado warning communication ended despite continued storm activity and active warnings still present within the DMA.

Based on this review of previous literature, this study provides a fundamentally different approach to understanding broadcast meteorologists and their processes for providing severe weather coverage for tornado warned storms. Here, we examine broadcast meteorologists directly by questioning their procedures for deciding when to provide coverage for particular places within a DMA and pair their responses with mapped representations of their spatial depictions for actual DMA boundaries. In doing so, the authors identify particular windows of communities who are vulnerable to receiving disproportionate levels of severe weather coverage from their local broadcast meteorologists, which are significant in affecting the public's ability to receive quality information about severe weather warnings and their ability to seek protective action. Additionally, we identify where broadcast meteorologists focus their attention geographically, and why.

3.3. Methodology

In this section, we introduce the study research questions, describe sampling and data collection, and explain analysis methods used.

3.3.1. Study Research Questions

The present research evaluates Oklahoma-based broadcast meteorologists and their decisions for providing live, on-air coverage of tornado outbreaks associated with severe weather events to communities comprising their designated market area (DMA). This paper refers to live coverage as continuous, wall-to-wall reporting that prioritizes the broadcast meteorologist's active engagement with risk communication to provide viewers with constant monitoring and updates of an event as it unfolds. Some research has shown that many broadcast meteorologists provide inconsistent levels of reporting throughout their designated market area (DMA) without any apparent justification (Cario 2016, Ebner 2013); hence, we sought to determine how broadcast meteorologists make decisions regarding when to provide or discontinue their live coverage of severe storms through place-based perspectives and geographic inquiry (RQ1). Specifically, we investigate how well they utilize and understand their DMA in a geospatial context as part of their decision-making process (RQ2). Since an earlier investigation found that broadcast meteorologists had varying opinions about urban and rural residents' ability to receive, understand, and respond to severe weather information (Walters et al. 2020), this paper also sought to identify how well they understood their viewing audience and how such preconceptions shape the way information is communicated across a DMA (RQ3).

Our research questions, more formally stated, were as follows:

RQ1: What factors shape the decision to begin or discontinue providing live, on-air coverage for severe storms?

RQ2: How spatially cognizant are broadcast meteorologists of their DMA? Do certain places inside the viewing market receive inadequate severe weather coverage?

RQ3: What do broadcast meteorologists believe their viewers know and understand, and how might this affect their severe weather coverage?

3.3.2. Sampling and Data Collection

This study focused on broadcast meteorologists from three of Oklahoma's Designated Market Areas (DMAs) – Oklahoma City, OK, Tulsa, OK, and Wichita Falls, TX – Lawton, OK – and is shown below in Figure 7. Presently, the Oklahoma City, OK DMA ranks #43 in the U.S. and provides service to approximately 666,690 homes (0.62% of U.S.). The top four television networks for this DMA include NBC-affiliate KFOR-4, CBS-affiliate KWTV-9, ABC-affiliate KOCO-5, and Fox-affiliate KOKH-25. Next, the Tulsa, OK DMA ranks #58 in the U.S. and services nearly 509,560 homes (0.48% of U.S.). The top four television networks for this DMA include NBC-affiliate KJRH-2, CBS-affiliate KOTV-6, ABC-affiliate KTUL-8, and Fox-affiliate KOKI-23. Lastly, the Wichita Falls, TX – Lawton, OK DMA is shared between Oklahoma and Texas, ranking #147 in the U.S. and providing service to roughly 132,830 homes (0.12% of U.S.). The top television networks include NBC-affiliate KFDX-3, CBS-affiliate KAUZ-6, ABC-affiliate KSWO-7, and Fox-affiliate KJTL-18.

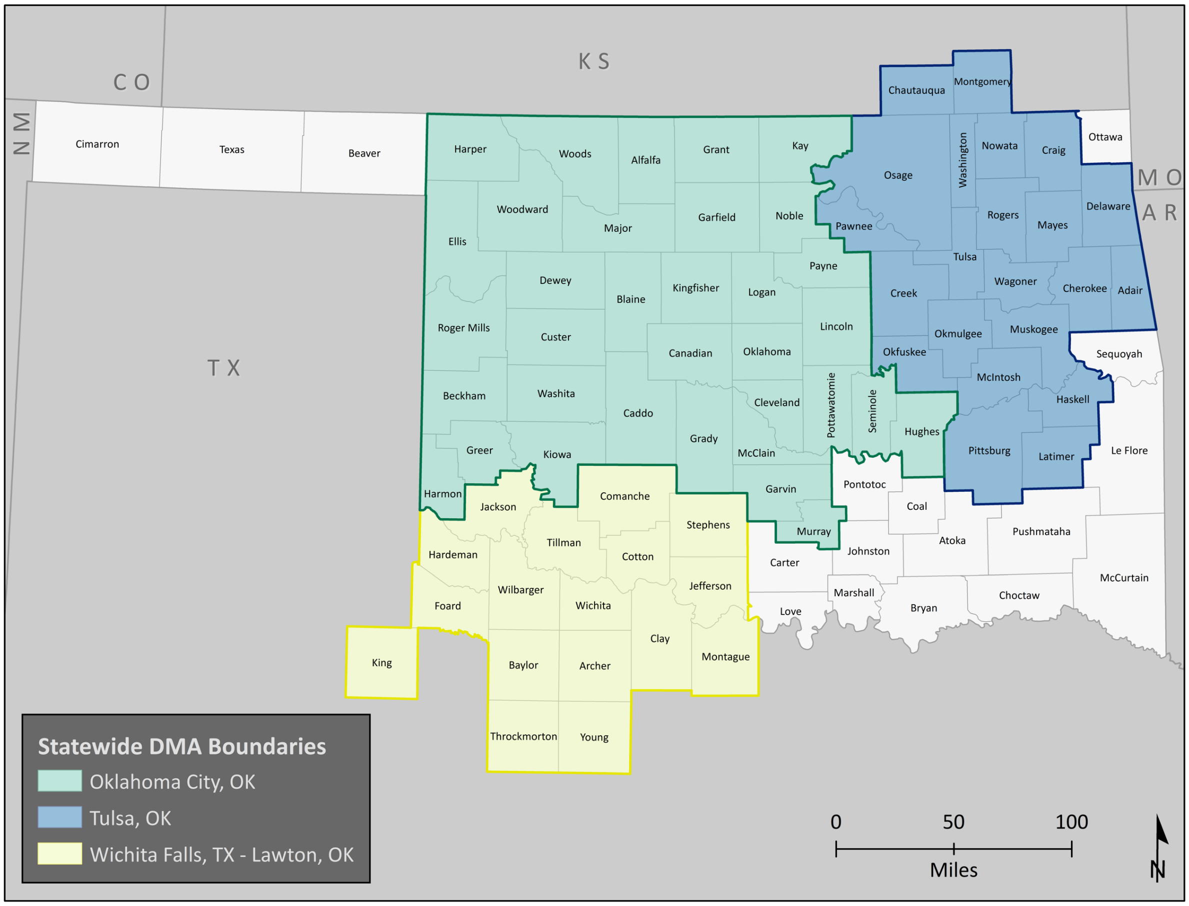

Figure 7. Oklahoma Designated Market Area (DMA) boundaries from which the sample was drawn for this study.

Broadcast meteorologists throughout the study region were reached using a random sample method supplemented by snowball sampling (Heckathorn 2002). Respondents were initially sent email invitations requesting their participation in an online survey. Email addresses for each broadcast meteorologist were obtained from their associated television stations publicly accessible contact webpage. In cases where no email address was found, we then sent private messages to request participation through their social media webpage (e.g., Facebook and Twitter). Unfortunately, not all broadcast meteorologists responded to the survey invitation despite several attempts to contact them. Those who did participate were asked to extend the invitation to other broadcast meteorologists that they worked with at the station, which greatly helped our outreach to gather a substantial sample size.

In all, 20 out of approximately 45 possible broadcast meteorologists across the study area took part in this research. The sample was 55% male (n = 11), 15% female (n = 3), and 30% remained anonymous (n = 6). For specific associations with a designated market area (DMA), 30% (n = 6) of the sample came from the Oklahoma City, OK DMA, 40% (n = 8) came from the Tulsa, OK DMA, and 30% (n = 6) came from the Wichita Falls, TX – Lawton, OK DMA. The respondents overall experience as a broadcast meteorologist range from 3 months to 36 years (μ = 14.16 years); broadcasters from Oklahoma City, OK average 12.83 years of experience, 19.64 years for Tulsa, and 9.8 years for Wichita Falls, TX – Lawton, OK, respectively. However, looking across the entire study area, 45% (n = 9) of the sample had less than 10 years of experience, 20% (n = 4) had between 10 and 19 years of experience, 15% (n = 3) had between 20-29 years of experience, and 20% (n = 4) had more than 30 years of experience. Thus, the sample skewed more male and to those that had lesser experience than the average broadcast meteorologist for the State of Oklahoma. These characteristics are provided in Table 1. Specific associations, such as their specific television station and age, are not provided to ensure anonymity and confidentiality, although direct quotations and paraphrases discussed in the results section are followed by "Broadcaster #" (i.e., the number corresponding to the respondent) to provide clarity for the reader.

Sample Characteristics	(n/20)	(%)	μ Employment (years)
Gender			
Male	11	55%	
Female	3	15%	
Anonymous	6	30%	
Years of Employment			14.16
< 10	9	45%	
10 - 19	4	20%	
20 - 29	3	15%	
≥ 30	4	20%	
DMA			
Oklahoma City, OK	6	30%	12.83
Tulsa, OK	8	40%	19.64
Wichita Falls, TX - Lawton, OK	6	30%	9.8

Table 1. Respondent demographic information for broadcast meteorologists surveyed in this study.

This study utilized an innovative survey approach, in which broadcast meteorologists were able to complete an interactive online Qualtrics survey to answer questions about their decision-making processes and geographical awareness regarding their respective designated market area (DMA). The survey first asked respondents to identify the counties belonging to their DMA when given a blank map of South-Central U.S. counties. This question was, “To the best of your ability, please select all of the counties that are within your designated market area (DMA) on the map provided below.” They were then asked to select the counties they perceived as more likely to view their station’s live severe weather coverage using the same interactive map. This question was, “To the best of your ability, please indicate which areas you feel are more likely to tune in to your station’s live broadcast during a severe weather event.” For these questions, respondents were able to individually select or unselect particular counties to record their answers. This map is provided, along with the survey questionnaire, in Appendix A.

Next, respondents were asked to describe the procedures they followed when providing coverage during a severe weather event. These questions ranged from their decisions to provide or discontinue live coverage, what particular kinds of information they included in their coverage, and whether or not they received guidance on these decisions from other members at the station. Specifically, these questions were "At what point does your station *begin/end* severe weather coverage?", "How does your station decide when particular kinds of information are covered during a severe weather event? (e.g., reporting the storm's trajectory versus reporting aftermath and damages)", and "During severe weather events, who makes the decision to interrupt prescheduled television programs to alert the public about severe weather warnings?".

Respondents were also questioned about the geographic extent and quality of their coverage for particular places within their respective DMA. These questions inquired about their decision-making processes for providing coverage to bordering counties of their DMA and whether or not they believed coverage could improve for certain places. More specifically, these questions probed to what extent they agreed upon certain urban and rural dynamics. These questions were, "Do you feel that severe weather coverage focuses on urban communities *more than* rural communities?" and "How could severe weather coverage improve for counties along the outer edges (e.g., along the boundary) of your DMA?".

Lastly, participants detailed their thoughts about how well their viewers understood content within their broadcast, as well as information they preferred to see. This question was, "What are your thoughts about how viewers understand and respond to severe weather coverage?". Respondents were then asked to list and/or describe the types of content they believed their viewers preferred to see included during their live severe weather coverage. Additional questions not mentioned here can be found in the full survey transcript provided in Appendix A.

3.3.3. Data Analysis

To examine how broadcast meteorologists utilize their subjective interpretations of DMAs to assist in their decision-making process, we incorporate a relatively new research design known as qualitative geographic information systems (qGIS). This technique facilitates a mixed-methods approach that combines qualitative data collected in our survey and presents them within conventional quantitative GIS technologies (Cope and Elwood 2009, Knigge and Cope 2006). By incorporating qGIS into this work, we can integrate spatial data and respondents' perceptions of places relative to their DMA to explore how the two dimensions interact. Moreover, we utilize qGIS to create cartographic representations that spatially depict broadcast meteorologists' knowledge and cognizance of their respective DMA.

By examining place-based perspectives and presenting them cartographically, qGIS enables researchers to document, communicate, and share meaningful experiences for particular geographical viewpoints (Roth 2020, Knowles et al. 2016, Kwan and Ding 2008). One group of researchers have looked at mixing narrative data with mapping capabilities of GIS in what they termed "geo-narratives" (Roth 2020, Knowles et al. 2016, Kwan and Ding 2008). Roth (2020) argues that map-based representations create intuitive and compelling stories designed to represent people's various interpretations and inner-workings with place. Moreover, Knowles et al. (2015) and Kwan and Ding (2008) propose that maps are not static and change across cultures through space and time. In this way, maps themselves do not tell stories as they are shaped by personal context and experience. Our analytic approach models grounded theory proposed by these scholars in a way that digitizes qualitative information and presents them cartographically with an endeavor to improve broadcast meteorologist's severe weather coverage through examining their viewpoints of spatial relationships.

To draw meaningful inferences about where broadcast meteorologists focus their live coverage geographically, we mapped in geographic information system (GIS) utilizing ESRI ArcGIS software, ArcMap 10.7. Survey data were layered with the 2017-2018 DMA shapefile (.shp) retrieved from ArcGIS Online (ESRI 2017). The three DMA boundaries comprising this study – Oklahoma City, OK, Tulsa, OK, and Wichita Falls, TX – Lawton, OK – were manually selected and extracted from the file. Notably, the DMA region for 2017-2018 is the same for 2018-2019 measurements (The Nielsen Company, LLC 2018).

We first created maps that showed how well respondents could identify the full extent of their DMA and the counties comprising this area. This was done by manually selecting counties that were chosen by broadcast meteorologists while taking the survey and representing them with the chosen color that signified their DMA (see Figure 7). Next, maps were created for each DMA to show the number of times particular counties were selected by respondents associated with the DMA to represent the counties that were perceived as being more likely to view their severe weather coverage. These maps were created by generating a summation column that represented the total number of times particular counties were selected by respondents. Finally, these results were compiled to create a statewide map that aggregated the counts across the entire study region. Each map presented in this work identified potential occurrences where broadcasters lacked spatial awareness of the entirety of their DMA, as well as particular counties that were perceived as being more or less attuned to their station's severe weather coverage. Moreover, the final statewide map allowed us to examine the potentiality for statewide trends.

Only 16 of the 20 broadcast meteorologists who participated in this work responded to the survey's geospatial questions. Of the 16, four were from Oklahoma City, six were from Tulsa, and six were from Wichita Falls, TX – Lawton, OK. To account for uneven sampling across the study region, we incorporated an approach known as post-stratification weighting (Kulas et al. 2018). This method statistically adjusted underrepresented samples, such as in the Oklahoma City DMA, to accurately represent the population distribution. To accomplish this, we first created a *Population (N)* column containing the total number of respondents who participated in this study (N = 20) and separated them into their corresponding DMA. Then, we created a *Sample (n)* column containing the sample who participated in the survey's geospatial section. This enabled us to calculate proportional values for both the population parameter (e.g., 6 Oklahoma City respondents divided by 20 respondents in the total population is 0.300) and the sample's statistics (e.g., 4 Oklahoma City respondents divided by 16 respondents in the sample is 0.250) by dividing each value by its respective total count. *Proportion of Population* values were then divided by *Proportion of Sample* values to determine the *Weight* for each DMA. After computing weights for each DMA, the weights were multiplied to the summation columns that were utilized for mapping each DMA separately. The individual weighted columns were then added together to generate a total weighted count column, which became the basis for generating the statewide perception map. Table 2, below, illustrates the post-stratification estimates of the study region.

Variables	**Population (N)**	**Proportion of Population**	**Sample (n)**	**Proportion of Sample**	**Weight**
Oklahoma City, OK	6	0.300	4	0.250	1.200
Tulsa, OK	7	0.350	6	0.375	0.933
Wichita Falls, TX - Lawton, OK	7	0.350	6	0.375	0.933
Total	**20**		**16**		

Table 2. Sample weights applied in the post-stratification adjustment. This procedure allowed us to accurately map statewide trends in perceived viewership shown in Figure 12.

As qGIS analysis provides narrative visualization, we also supplement this work with a thematic approach (Braun and Clark 2006) that reflects the meanings, experiences, and reality of the respondent's spatial interpretations. This approach is grounded in the notion that for a given phenomenon or aspect of a question, there are a number of qualitatively different ways in which one can perceive, experience, or understand it. We have characterized broadcast meteorologists' perceptions of live severe weather coverage as several emergent themes related to their interpretations of space and place and discuss these elements in a narrative context regarding decision-making inside their DMA. Therefore, we create survey response tables that are organized and presented to address the three main themes discussed in this paper: (1) When to Cut-In: Policies and Procedures, (2) Spatial Cognition of DMAs, and (3) Perceptions of Viewer Needs and Knowledge. The tables were constructed to show a distillation of individual responses to key questions from the survey and can be found in Appendix B. Here, we utilize an inductive coding scheme that highlights the variety of constructs employed by the respondents and extract the most salient responses for discussion.

3.4. Results

This section discusses broadcast meteorologists' numerous ways of knowing and interpreting designated market areas (DMAs) as it relates to their decisions surrounding live severe weather coverage. Phenomena discussed herein provides insight into the combination of factors that impact their decision to provide adequate and consistent coverage to the diverse set of communities encompassing their DMA.

3.4.1. When-to-Cut-In: Policies and Procedures

As severe storms capable of producing tornadoes move into a designated market area (DMA), local broadcast meteorologists must decide how and when they will provide live severe weather coverage structured around continuous, wall-to-wall engagement. Oklahoma-based broadcast meteorologists surveyed in this study expressed an overall belief that the decision to begin or discontinue such coverage largely depended upon the storm's positioning and trajectory within the DMA. One broadcast meteorologist specifically mentioned referencing a county-map of their DMA before deciding to preempt regular programming to ensure coverage would be transmissible to the affected area [Broadcaster #1].

> "We have a designated map for severe weather coverage, meaning, we have highlighted the areas we are confident that our TV signal reaches. We consider those counties to be priority on air live during tornado warnings. We also have 'watch' counties, meaning, no TV coverage is necessary, but we should monitor storms closely in case they move into the DMA." [Broadcaster #1 M, Wichita Falls, TX – Lawton, OK DMA]
>
> "If the severe weather is not in our DMA, we don't cut-in except in extreme severe weather situations (moderate- or high-risk)." [Broadcaster #2 M, Oklahoma City, OK DMA]

While broadcast meteorologists utilize their DMA to guide their severe weather coverage, they also rely on their perception of storm severity [Broadcaster #2]. For example, if storms were expected to be more mild, coverage was said to begin when the storm officially *entered* the DMA; however, if storms were expected to be more severe, coverage was said to begin *before* the storm entered the DMA. The same remark persisted for the decision to discontinue live coverage, which suggests that coverage would continue into neighboring DMAs for storms of greater severities or days deemed by the SPC as moderate- or high-risk. When asked about their decision to cover counties falling outside of their traditional DMA region, broadcast meteorologists practiced the same standard. It was said that coverage would only include counties in neighboring DMAs to the east and west if storms were more severe and particularly dangerous.

> "We will only cover border counties if the weather is severe enough and the population is large enough." [Broadcaster #3 F, Wichita Falls, TX – Lawton, OK DMA]

> "If we have a huge weather event impacting western and central Oklahoma, often we focus on damage in the Metro more than focusing on warnings pushing into our eastern fringe of our DMA." [Broadcaster #4 F, Oklahoma City, OK DMA]

> "It [severe weather coverage] would be improved if we treated them [fringe counties] like our main counties – we have been called off air while covering a tornado in our furthest county because the programming was 'too important.'" [Broadcaster #5 F, Tulsa, OK DMA]

In addition to broadcaster's perception of storm trajectory and severity, several stated that their decisions depended on the populations affected. When communicating severe weather warnings, smaller and more rural population centers tend to receive inadequate time and attention than larger urban populations nearby. For example, as storms move west past an urban metropolitan area, broadcast meteorologists shift their focus to reporting aftermath and damages even as severe weather persists for more rural communities in the eastern fringe of the DMA. Broadcast meteorologists in this study even admitted to being called off-air for covering storms affecting counties with smaller populations in the furthest portion of their DMA [Broadcaster #5]. These broadcasters believed that coverage would significantly improve if there were no tendency to lessen coverage after storms passed larger population centers and if their rural fringe counties received coverage in the same way as more urban counties centered within their DMA.

> "Station management is very inconsistent on input of severe weather coverage. Most often input is provided only when there is a perception that coverage will negatively impact revenue." [Broadcaster #6 M, Wichita Falls, TX – Lawton, OK DMA]

> "It is generally left up to the meteorologist but there are times, particularly during certain programs, when management will make coverage decisions and communicate those decisions to staff other than the meteorologist." [Broadcaster #6 M, Wichita Falls, TX – Lawton, OK DMA]

> "Depending on other programming (live sports, events, etc.) we may cut in to programming vs. leave a screen crawl up. Tornado warnings, with very few exceptions, are always cut into programming immediately." [Broadcaster #7 M, Tulsa, OK DMA]
> "There are few counties we will not do wall-to-wall coverage for tornado warnings, and instead we treat their tornado warnings like severe thunderstorm warnings (we only cover them during commercials)." [Broadcaster #5 F, Tulsa, OK DMA]

The majority of broadcast meteorologists identified one or more ways their station selected the areas they cover during a severe weather event. In some cases, it was stated that station management would provide input on a broadcaster's coverage when there was a perception that it would negatively affect revenue; however, this advice seemed inconsistent, and coverage mostly depended on the type of programming on-air at the time (e.g., live sporting event, reality show, etc.) [Broadcaster #6]. As such, the type of programming on-air at a given time determined how broadcast meteorologists decided to preempt and provide live coverage. Typically, shows that retained a large number of viewers, such as sporting events and reality shows, were not preempted, and viewers were instead provided warning information with scroll bars and bugs placed at the bottom corner of the screen. Alarmingly, one broadcaster stated that some counties did not receive live coverage for tornado warnings and were instead treated as severe thunderstorm warnings, which are only preempted during commercial breaks [Broadcaster #5]. Broadcast meteorologists also surmised that their station may decide to opt-out of providing live coverage due to the impression of other stations already covering the storm and that their decision to provide coverage for any county falling outside of their DMA depended upon the quality of coverage taking place by broadcast meteorologists in neighboring DMAs, thereby implying that the way broadcast meteorologists structure their coverage geographically (i.e., discussing threats for urban and rural locals) affects the way competitor stations approach their coverage decisions. Despite these peculiarities, most broadcasters professed that live coverage would be provided for as long as there were active tornado warnings within the DMA regardless of the developed environment or population size. The way in which one provides coverage, however, is subject to vary.

3.4.2. Spatial Cognition of DMA regions

In addition to the described commentary from broadcast meteorologists, we sought to identify spatial variations in context through the use of GIS mapping. Below, we further examine relationships for each of the three individual DMAs defined in this study and then all together as a region.

To further understand broadcast meteorologist's spatial knowledge, we first asked them to identify the counties they were responsible for providing coverage to when given a blank county map, as predetermined by Nielsen Company DMA measurements (The Nielsen Company, LLC 2018). We then asked them how long they had been working in a role where they made live coverage decisions. Figure 8 utilizes their responses to identify their spatial awareness in correspondence to their length of employment. This was done to see if the amount of time working as a broadcast meteorologist paralleled with their familiarity of their respective DMA. In examining their responses, we saw that it was common for broadcasters to either fully identify or overestimate the counties belonging to their DMA regardless of their length of employment.

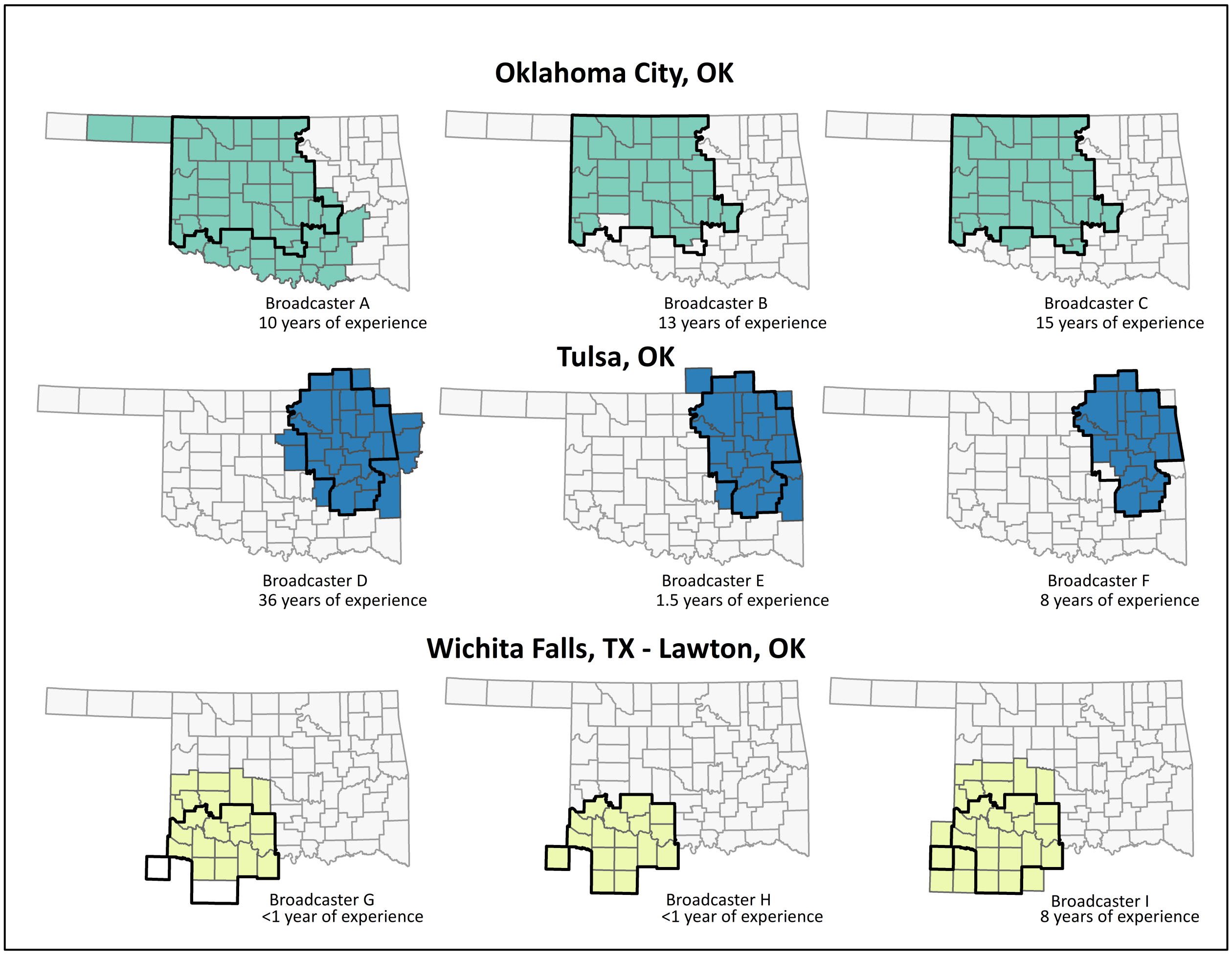

Figure 8. Perceived Designated Market Areas (DMAs). These maps highlight Oklahoma-based broadcast meteorologist's depictions of their respective designated market area (DMA). Respondents were initially provided a blank county map to record their answers. The compiled responses are overlaid with 2017-2018 DMA boundary measurements (The Nielsen Company, LLC 2018).

Although the three DMAs share much in common geographically, each county houses demographically distinct populations. Generally, DMAs are identified by the largest city, which is usually located in the center of the market region. However, geography and the fact that some metropolitan areas have large cities separated by some distance can make markets have two or more names being used to identify a single region, such as Wichita Falls, TX – Lawton, OK. For this reason, counties central to the DMA typically contain larger suburban towns with relatively affluent populations, whereas counties along the outer edge of the market encompass smaller rural residential districts. Interestingly, counties that were overestimated by broadcast meteorologists were those that are smaller, less populated, rural towns.

Next, we examined broadcast meteorologists' opinions about the counties they perceived as more likely to view their television station's live coverage during a severe weather event. 16 (n) of the 20 (N) total broadcast meteorologists sampled participated in this section, with only 4 broadcast meteorologists contributing from Oklahoma City, OK ($n_s = 4$), and 12 broadcast meteorologists totaling between Tulsa, OK ($n_s = 6$) and Wichita Falls, TX – Lawton, OK ($n_s = 6$). Figures 9 through 11 highlight these findings for each DMA, respectively. Each figure is formatted to show combined responses while also offering individual responses to indicate varying discernments. Additionally, the maps are presented with city references as they would normally be presented in a televised weather broadcast to help orient the viewer.

3.4.2.1. Oklahoma City, OK DMA

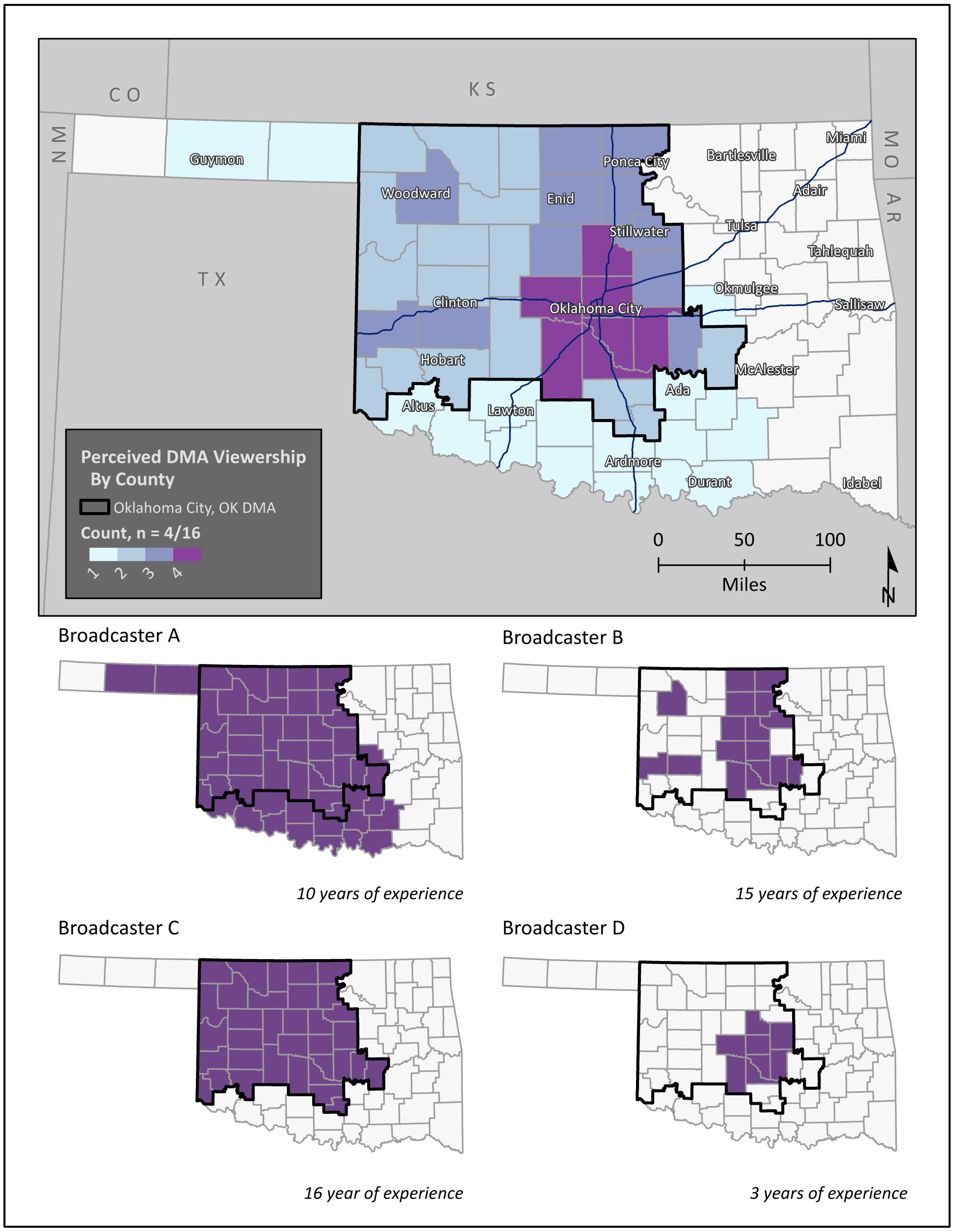

Figure 9. Perceived Viewership within the Oklahoma City, OK DMA. This map depicts responses from local broadcast meteorologists in Oklahoma City's DMA when asked to identify counties perceived as being more likely to view their stations severe weather coverage. The top portion of the map highlights combined responses ($n_s = 4$, $n = 16$, $N = 20$) and the bottom portion provides individual discernments for additional context. The maps are overlaid with 2017-2018

DMA boundary measurements to help deduce potential geospatial predispositions (The Nielsen Company, LCC 2018).

Looking across the Oklahoma City, OK DMA, there is an apparent perception among broadcast meteorologists (n_s = 4 of 4) that counties immediately surrounding the Oklahoma City metropolitan area are more likely to tune in to view their local broadcaster for severe weather updates (Figure 9). It is important to note that Oklahoma City's city limits extend somewhat into Canadian, Cleveland, and Pottawatomie counties, though much of those areas outside the core Oklahoma County area are suburban tracts. Broadcast meteorologists (n_s = 3 of 4) also specified that three counties in the far west portion of the DMA are more likely to view their live broadcast. These counties – Washita, Beckham, and Woodward – comprise the state's two commercial hubs of western Oklahoma – towns Woodward and Clinton.

The towns that Oklahoma City broadcast meteorologists identified are extremely varied and range from affluent neighborhoods to nearby impoverished communities. Generally, Oklahoma City counties are bisected geographically and culturally to the north and south. North Oklahoma City is characterized by very diverse urban neighborhoods and sprawling suburbs, whereas South Oklahoma City is characterized as being more industrial and the blue-collar working class. There are some places in South Oklahoma City, however, that are more affluent, such as the two cities Norman and Moore, which are suburban university towns. Counties in Western Oklahoma symbolize the state's western frontier, and towns are mostly suburban neighborhoods that are considered cattle towns centralized around agricultural businesses.

Moreover, Figure 9 suggests that broadcast meteorologists in the Oklahoma City DMA tend to believe larger population centers are more likely to view their coverage, which is synonymous with where the majority of the viewing population lives in the DMA. Oklahoma City is the

DMAs largest city by population size, estimating nearly 650,000 residents within Oklahoma City city-limits and up to 1.4 million throughout the entire metropolitan area. While western Oklahoma's population is sparser, the towns Woodward and Clinton combined hold nearly 21,000 residents, which is much larger than neighboring towns.

Notably, these depictions show mixed results when comparing it with their length of employment. For example, at the time of data collection, Broadcaster D only had three years of experience and had selected counties that make up the immediate Oklahoma City metropolitan area. In contrast, Broadcasters A and C had much greater experience (e.g., 10 to 16 years of experience) levels and their perceptions more accurately reflected current DMA measurements. Broadcaster B, however, provides an exception to this assumption, as this individual had 15 years of experience and solely selected counties housing the largest population centers within the DMA.

3.4.2.2. Tulsa, OK DMA

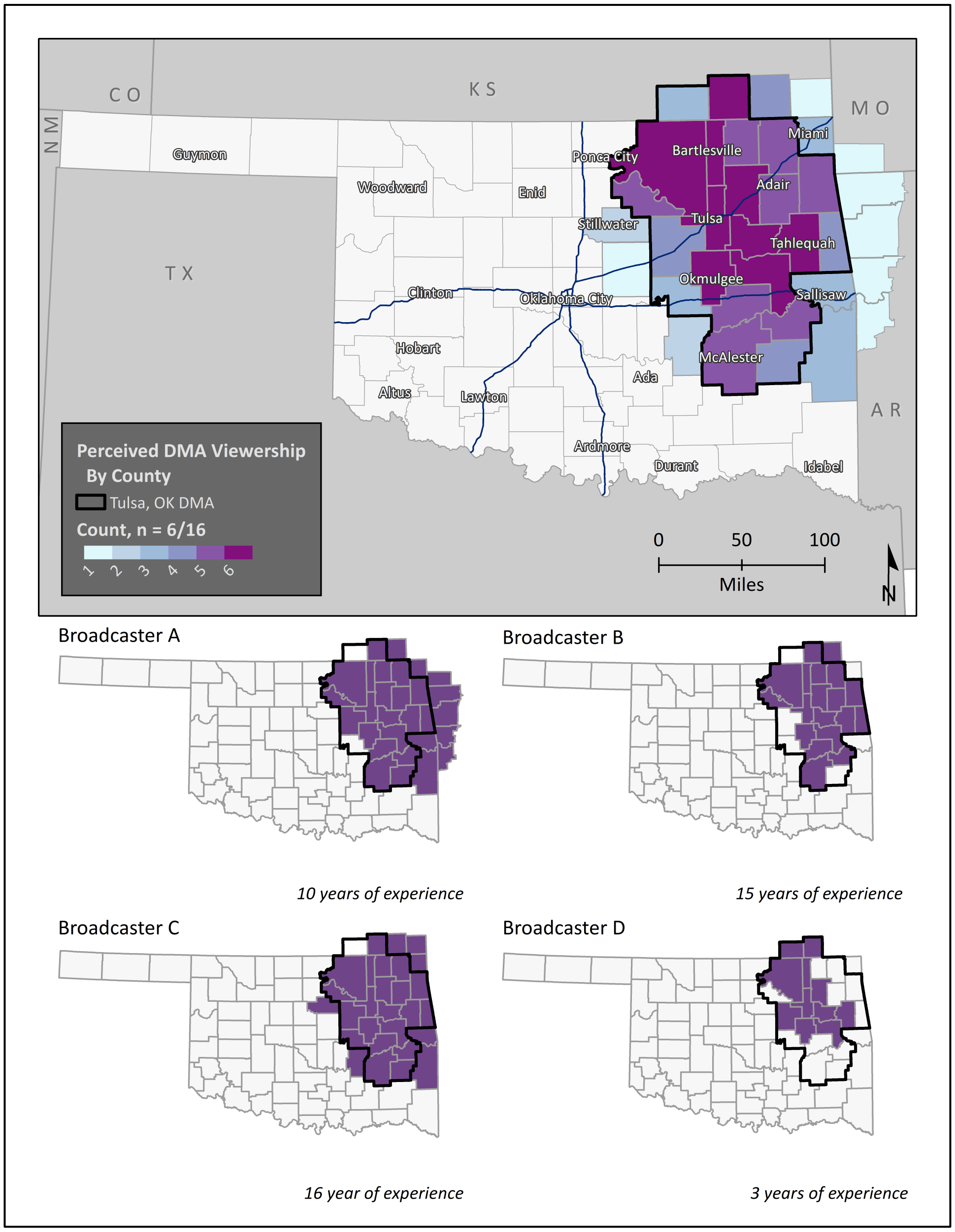

Figure 10. As in Figure 9, but for local broadcast meteorologists within Tulsa's DMA (n_s = 6, n = 16, N = 20).

Similar trends are seen across the Tulsa, OK, DMA, as shown above in Figure 10, which imply that counties incorporating an urban metropolitan area are perceived to have greater viewership during a severe weather event. Specifically, Tulsa broadcast meteorologists (n_s = 6 of

6) examined in this study believed that counties consisting of Tulsa's metropolitan area were more likely to tune in to their station's severe weather coverage as compared to the rest of the DMA. The city of Tulsa is the second-largest city in the State of Oklahoma, and its metropolitan area occupies a large portion of the state's northeast quadrant, which explains why broadcaster's selections were generally more widespread. Tulsa's metropolitan area spans seven counties, including Tulsa, Rogers, Osage, Wagoner, Okmulgee, Pawnee, and Creek. Altogether' Tulsa's city limits estimate a population size of nearly 953,000 residents, while the greater combined metropolitan area extends from Tulsa, east to Tahlequah, and north to Bartlesville houses an estimated population of 1.1 million residents. Due to its large size, Tulsa's urban metropolitan area intersects many diverse towns and neighborhoods.

Overall, the north side of Tulsa's city limits is home to a large percentage of working-class individuals and lower-income households. However, the south and east side is popularly considered suburban-style neighborhoods with more affluent demographics. This includes the suburban towns Bixby to the south and Broken Arrow to the east. Communities on the west side of Tulsa are very industrial and are concentrated around oil production and factories. Other towns on the perimeter of Tulsa's metropolitan area, such as Bartlesville (North), Tahlequah (East), and Okmulgee (South), are communities with small population densities and are mostly rural by area. Therefore, while broadcast meteorologists in Tulsa's DMA generally selected counties central to the DMA, each county contains a wide variety of demographic characteristics, with rural and urban alike.

When examining the influence of experience, the length of employment for Tulsa-based broadcast meteorologists more closely aligns with the idea that experience affects how they perceive places and probably viewership within their DMA. For example, both Broadcaster A, B, and C had more than 10 years of experience and generally believed their entire DMA was likely to view their station's live coverage. Broadcaster D, however, had only three years of experience and mainly selected counties comprising Tulsa's urban metropolitan area. Like Oklahoma City, though, this theme fades when considering total combined responses.

3.4.2.3. Wichita Falls, TX – Lawton, OK DMA

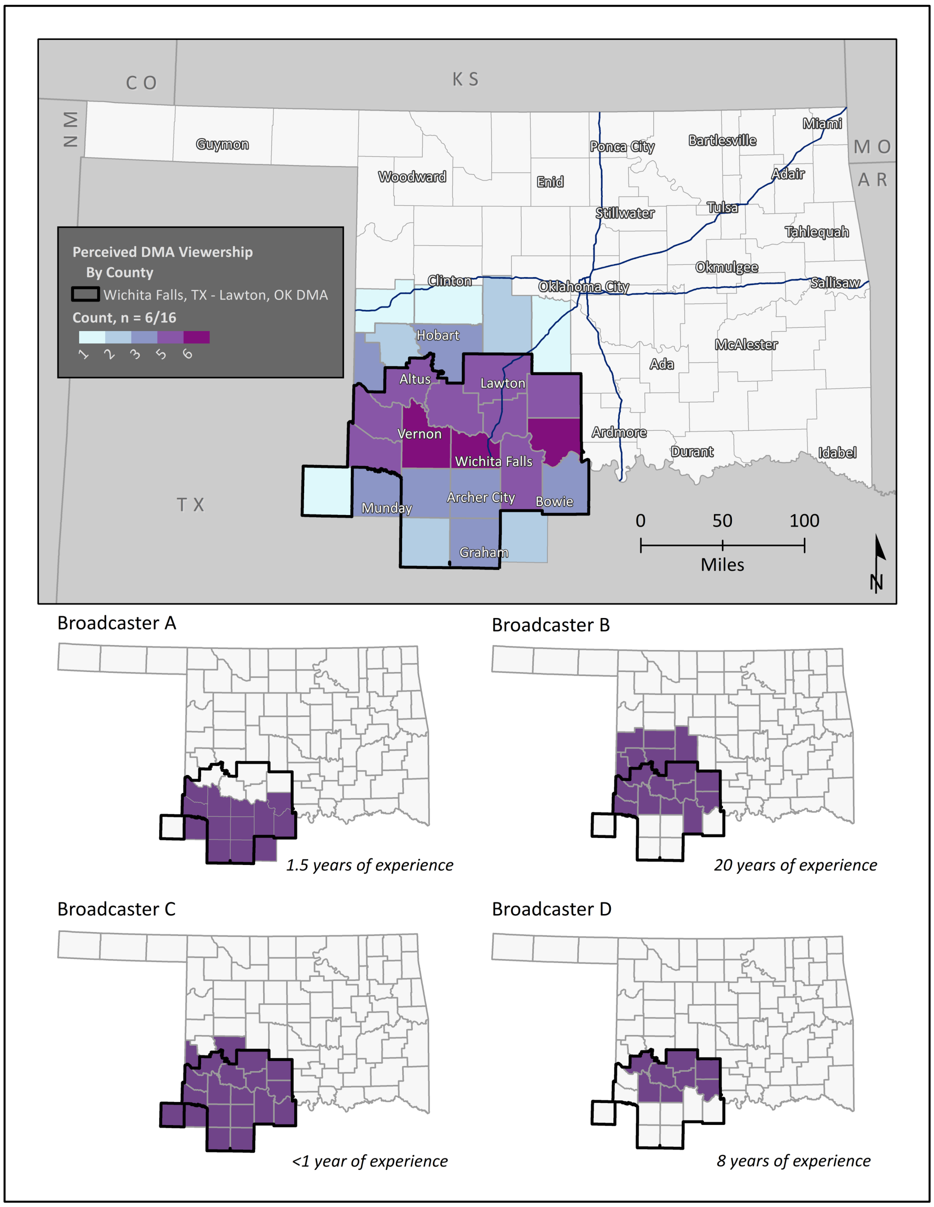

Figure 11. As in Figures 9 and 10, but for local broadcast meteorologists in the Wichita Falls, TX - Lawton, OK DMA ($n_s = 6$, n = 16, N = 20).

Intriguingly, inclinations found among Oklahoma City and Tulsa broadcast meteorologists do not appear as straightforward when looking at responses from the Wichita Falls, TX – Lawton, OK DMA. Broadcast meteorologists sampled from this DMA generally expected higher viewership in counties along the Oklahoma-Texas state border ($n_s = 5$, $n = 6$), which are central to the DMA, and deemed the DMAs southern border counties as having lower viewership ($n_s = 3$, $n = 6$). Specifically, their selections indicated that residents in two Texas counties, Wilbarger and Wichita, and one Oklahoma county, Jefferson, were more likely to tune in to their station's live severe weather coverage (Figure 11).

It is worth noting that the Wichita Falls, TX – Lawton, OK DMA is much different from the two preceding markets examined in this study. First, this DMA is much smaller by geographic area and population size. Communities within the region tend to be more geographically spread, rural, and less populous. Even the DMAs two major urban metropolitan areas, Lawton, Oklahoma, and Wichita Falls, Texas, offer its residents a small suburban-like feel. Collectively, the two towns house just under 200,000 residents, with nearly 93,000 people in Lawton, Oklahoma, and 104,000 people in Wichita Falls, Texas. The DMAs population is not much larger and estimates about 233,000 residents across the entire region. The counties that broadcast meteorologists selected, such as Wichita and Wilbarger, contain two Texas towns – Vernon and Wichita Falls – which are smaller middle-class suburbs with spread-out populations in the county area.

Many selections even spilled over into neighboring DMAs, primarily north into Oklahoma City's DMA. These counties incorporate the largest cities of southwestern Oklahoma, such as towns Clinton and Hobart, which suggests that broadcast meteorologists have a general tendency to think that counties of comparative population size that are further away from the state's capitol, Oklahoma City, are more likely to view their station's live coverage. Additionally, individual selections made by Wichita Falls, TX – Lawton, OK broadcast meteorologists imply that they rely less on urban-rural dynamics and population size and more on subjective state border dispositions. This is seen in Broadcaster A and Broadcaster B, where Broadcaster A solely selected Texas counties and Broadcaster B primarily selected Oklahoma counties.

Looking at the effect of time, the length of a broadcast meteorologist's employment shows mixed results. Most of the broadcast meteorologists in this DMA have less experience than those working in neighboring markets. However, we generally see that Wichita Falls, TX – Lawton, OK broadcast meteorologists situate their opinions around the state border, especially among those with considerably more experience like Broadcaster B with 20 years and D with eight years. Contrary to inferences from the previous DMAs, we see that Broadcaster C had less than one year of experience and perceived the entire DMA to be equally likely to view their station's live coverage. At the same time, we see that Broadcaster A, with only one and a half years of experience, believed most of their viewers stemmed from Texas counties. Overall, there is no discernable pattern of experience and their opinions of viewers.

3.4.2.4. Statewide

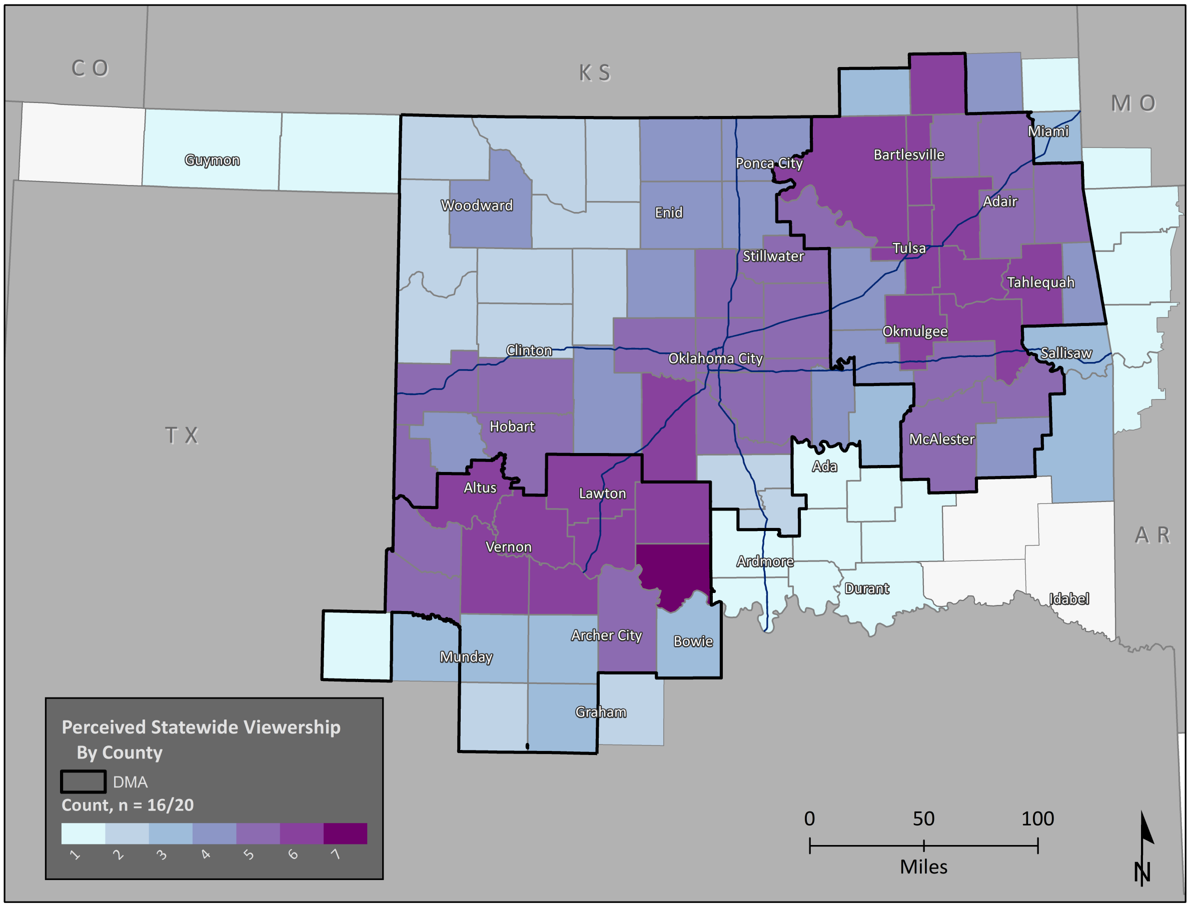

Figure 12. Perceived Viewership Statewide. Map depicting responses from Oklahoma-based broadcast meteorologists across the entire study region (n = 16, N = 20), which incorporates 3 Oklahoma DMAs: Oklahoma City, OK (n_s = 4), Tulsa, OK (n_s = 6), and Wichita Falls, TX – Lawton, OK (n_s = 6), when asked to identify counties perceived as being more likely to view their station's live severe weather coverage. Post-stratification weighting was applied to the data to account for uneven sampling across the region. This method allowed us to statistically readjust the sample to accurately reflect population parameters, making the results more generalizable across the study region. Weights were calculated by dividing the proportion of the population by the proportion of the sample for each DMA, as shown in Table 2. The map is overlaid with 2017-

2018 DMA boundary measurements to help deduce potential geospatial predispositions (The Nielsen Company, LCC 2018).

In addition to the described perceptions from each DMA, we combined the results from Figures 9 through 11 to show statewide trends in perceived viewership and is shown in Figure 12. Overall, broad regional trends emerge in a similar way for cities that were emphasized in individual DMAs (Figure 12). Of particular importance here is that broadcast meteorologists across the region (n = 16, N = 20) implied that urban communities, predominantly those surrounding large metropolitan areas, are more likely to view their particular stations live severe weather coverage than nearby rural communities, which is consistent with broadcaster's remarks discussed earlier in the paper.

Looking across the region, we see a tendency for broadcast meteorologists to perceive bordering counties to the north-northeast and south of the State of Oklahoma, primarily within the Oklahoma City, OK DMA, being less likely to view. These places are less populous and predominantly open farmlands. The selections confirm discernments from broadcast meteorologists discussed earlier in this paper, which insisted that coverage would be discontinued before storms fully exit their DMA due to a perception that the storm is no longer affecting significant population centers (i.e., large cities and towns).

Additionally, broadcast meteorologists' selections follow alongside the state's I-44 corridor, which is a major interstate highway aligned southwest-northeast that passes through many of the DMA's large urban metropolitan cities. Specifically, I-44 travels from Wichita Falls through Oklahoma City and northeast into Tulsa. The highway is also uniquely positioned in that it co-aligns with typical storm development patterns. As storms approach the State of Oklahoma and usually move northeast across the state, the I-44 corridor becomes a ripe spot for tornadic development. Broadcast meteorologists' responses confirm that their perceptions of place correspond with mid to large population centers near the state's highway.

3.4.3. Perceptions of Viewer Needs and Understandings

The final objective explored broadcast meteorologists' perceptions of their viewing audience, including their knowledge and preferences for content within their live coverage, which shape how information is communicated across a DMA. It seemed as though broadcast meteorologists were excited to talk about their viewers. It was truly an effective way to get the broadcaster's personal connections to place.

First, a common perception found among broadcast meteorologist's was that they believed many of their viewers understood complex meteorological information [Broadcaster #4, #8] but were unable to identify their location on a map due to a lack of geographic literacy [Broadcaster #7, #8].

> "I legitimately think there are some people that don't understand where they are on a map compared to major population centers (i.e., Tulsa) that hurt their ability to discern if storms are headed their way or not. Otherwise, I think most of the public is pretty well versed in severe weather terminology and readiness and knows how to get information." [Broadcaster #7 M, Tulsa, OK DMA]

> "Our viewers are very weather savvy and appreciate our weather coverage when severe weather moves in. They understand velocities, hail sizes, and wind gusts pretty well. The biggest thing they struggle with is geography and knowing where certain towns and cities are in comparison to their location." [Broadcaster #8 M, Wichita Falls, TX – Lawton, OK DMA]

> "I believe our viewers have some of the highest meteorological and severe weather knowledge in the country. That being said, some people are confused by certain warnings and watches. I believe that most Oklahomans know where to go during a tornado. However, there is a social science element – for example, if people are traumatized from a previous severe weather event, they may act irrationally and flee from a tornado instead of sheltering in place." [Broadcaster #4 F, Oklahoma City, OK DMA]

They perceived that confusion and doubt arose when viewers could not discern the storm's location and trajectory in relation to their place of residence, which was thought to cause people to react irrationally and not follow proper protective action. Thus, some broadcast meteorologists concurred that inaccurate knowledge relating to geography was problematic to how viewers engage and respond to elements within their severe weather broadcast.

When broadcasters were asked about what they thought their viewers preferred to see as content in their severe weather coverage, most agreed that viewers desired local, place-specific references when discussing severe weather risks and warnings.

> "They like visuals of the storm along with street-by-street radar coverage. They also want the meteorologists to reference other strong storms that will still be a nuisance, especially if near an urban center. Damage shots are also sought following a storm during our coverage." [Broadcaster #9 M, Tulsa, OK DMA]

> "Video, estimated time of arrival, street-level mapping, clear and accurate communication that is not overhyping the storm, impacts, and experience." [Broadcaster #10 M, Oklahoma City, OK DMA]

> "The response is that people like calm and concise, not overly inflated or scary." [Broadcaster #11 M, Tulsa, OK DMA]

This includes ground truth, such as the use of storm spotters and damage shots to visually validate tornadoes tracked on Doppler radar, street-level mapping, and the storm's estimated time of arrival [Broadcaster #9, #10]. In doing so, they also mentioned that their viewers preferred when they maintained calm and consistent verbiage to ensure that messages are clear and accurate and reduce the potential for sensationalizing or overhyping the storm [Broadcaster #10, #11].

Of course, while most broadcast meteorologists spoke positively about their viewers and even referred to them as having the highest weather knowledge in the country [Broadcaster #4], some believed their viewers were more self-involved. For example, one broadcast meteorologist felt that a part of the public did not care about nor have any interest in their severe weather coverage until it was directly affecting their community, suggesting that viewers thought live coverage was a nuisance [Broadcaster 2]. In this case, it was stated that viewers often complained about their local broadcast meteorologist utilizing their live coverage as a means of boosting their own ego [Broadcaster 2].

> "People seem to be very self-centered. If severe weather hits them, it 'came out of nowhere' despite days of accurate forecasting and constant severe weather updates. If they aren't being affected, we get calls about how we 'just want to stroke our own ego.' Severe weather seems to be held as another nuisance thing that people don't pay attention to until it's too late." [Broadcaster #2 M, Oklahoma City, OK DMA]

> "The most important thing I think is the storm track because that's all they care about. 'When will I get to my house.'" [Broadcaster #5 F, Tulsa, OK DMA]

Altogether, we found that broadcast meteorologists' decisions are primarily situated around their thoughts and opinions of where their viewers live, such as the separation between urban and rural population centers. They continually referenced their opinions of viewer knowledge and preferences for those in larger urban metropolitan areas. For example, Broadcaster #7 believed that viewers did not know how to identify their proximity to large population centers and impending severe weather threats. Broadcaster #9 professed that those residing in urban towns needed place-specific references to help orient themselves with the threat. Therefore, Broadcast meteorologists have a predisposition that while there are more viewers in places with larger populations, these communities struggle with understanding severe weather information compared to less populous rural towns.

3.5. Discussion and Summary

This paper helps us understand how Oklahoma-based broadcast meteorologists cover severe weather events in a geospatial context. Utilizing designated market areas (DMAs) as a spatial reference, these boundaries provide a valuable lens to recognizing how broadcast meteorologists disseminate warning information to particular places as a severe weather event unfolds. This research specifically examines Oklahoma-based broadcast meteorologists from three Oklahoma DMAs: Oklahoma City, OK, Tulsa, OK, and Wichita Falls, TX – Lawton, OK. The 20 broadcast meteorologists who participated in this study provided a novel contribution to understanding why certain communities often receive disproportionate or inadequate severe weather coverage within the state. Thus, this study was able to begin identifying where broadcast meteorologists focus their attention geographically, and why.

The frequent remark made by broadcast meteorologists about their tendency to emphasize urban metropolitan areas more than nearby rural places was perhaps the most compelling we heard and represented the range of our survey findings. During our surveys, broadcast meteorologists were asked to describe their decisions regarding when to begin or discontinue live, continuous wall-to-wall coverage for specific places within their respective designated market area (DMA). Many broadcast meteorologists noted that their decisions largely depended upon their perception of the storm's intensity and the populations that may be affected. Specifically, coverage was said to be provided for counties along the border of their DMA if there was an understanding that the communities in those areas were densely populated. These statements proved to be consistent with results from our spatial analysis, where we found that broadcast meteorologists perceived greater viewer retention in counties containing densely populated urban centers. Furthermore, we found that broadcast meteorologists emphasized counties central to the DMA and excluded fringe counties, which are Oklahoma's rural and less populous areas. Other research examining broadcast meteorologist's severe weather coverage also found that urban metropolitan areas receive more emphasis on warning communication and that coverage is discontinued as storms approach rural communities along the border of a DMA (Cario 2016, Ebner 2013).

Often, the decision to preempt regular programming and provide continuous coverage is not made by the broadcast meteorologist alone, as some mentioned receiving guidance from other non-meteorological members at the station. Additional guidance from station management and news directors was said to most often be provided when there is a perception that coverage could negatively impact revenue; therefore, the decision to provide coverage also depended upon the type of programming on-air at the time (e.g., sporting event, reality show, etc.). Prior research explains that broadcast meteorologists utilize a variety of methods to disseminate warning information, which does not always require the broadcast to provide a complete cut-in (Coleman et al. 2011). Suppose active warnings still exist within the DMA. In that case, broadcast meteorologists may resort to other means of warning dissemination that do not require interrupting programming, such as utilizing text scrolls or stationary graphics at the bottom corner of the television screen to deliver updates about the storm's risks, or by preempting only during commercial breaks (Coleman et al. 2011). In this way, regular programming may continue without disruption, and the television station continues to operate within the current Federal Communications Commission compliance (Federal Communications Commission 2020, Scherer 2018).

The statements made by broadcast meteorologists exemplified in this paper show that their decisions to provide live severe weather coverage are heavily rooted in their opinions of particular geographical groups. Mapped representations showing where broadcast meteorologists believe their outreach is the greatest (i.e., higher viewership) suggests that they believe residents within urban metropolitan areas are more likely to tune into their station's severe weather coverage than less populated rural places that seem to be geographically isolated (e.g., far away from a major population center). This study, therefore, highlights potential systematic problems that affect the ability for particular locales to receive adequate and consistent reporting throughout the entirety of an event.

Equally important in the study of how broadcast meteorologists communicate to various places are their ideas about their viewers' needs, preferences, and knowledge. Most broadcast meteorologists described their viewers as having exceptional weather knowledge due to living in an area that is frequently impacted by severe storms and tornadoes. Simultaneously, broadcast meteorologists believed their viewers struggled to identify their location on a map and could not spatially depict the storm’s trajectory relevant to their location. Thus, some broadcast meteorologists confirmed that inaccurate knowledge relating to geography was problematic to how certain locales engage and respond to severe weather coverage. These remarks coincide with claims initially presented by Alabama-based broadcast meteorologist James Spann, in which he conceded that a substantial percentage of the population were unable to identify their location when given a blank county map (Morgan 2019, Samenow 2019). However, this idea is heavily flawed as Klockow-McClain 2019 asserts that broadcast meteorologists rarely present a blank county map when presenting warning information. Broadcast meteorologists utilize both mapped representations and narrative descriptions to inform viewers about impending threats (Coleman et al. 2011), and research shows that televised media exposure of severe weather outbreaks does, in fact, increase one’s perceived risk and the likelihood of seeking shelter (Klockow-McClain et al. 2019, Zhao et al. 2019, Joslyn and Savelli 2018, Drost et al. 2016, Nagele and Trainor 2012). This differing opinion regarding the viewer's knowledge and understanding of weather warnings directly affects how a broadcast meteorologist communicates warning information to geographically and socioeconomically diverse places.

In this paper, we have attempted to explain how broadcast meteorologists utilize their DMA to make decisions about their live, continuous wall-to-wall coverage, which can be viewed through the lenses of geographic inquiry and cartographic visualization. We found that broadcast meteorologists' capability to distribute sufficient coverage to the entirety of a DMA not only depends upon their familiarity with the breadth of counties included within their DMA but, most importantly, their interpretations of the particular places within them. The viewpoints discussed in this work provide much-needed insight into the nuanced ways urban and rural places are exemplified within live severe weather coverage. With this viewpoint in mind, we encourage future research to examine the underpinnings of place-based perspectives further as it relates to decision-making about providing live severe weather coverage in a DMA. Many of these perceptions are driven by administrative forces or individual spatial cognizance that motivate how a broadcast meteorologist understands their local communities. While increases in geographic literacy can help promote more consistent coverage in some contexts, ultimately broadcast meteorologists' outlook about a place heavily sway how they make decisions (Cresswell 2015, Relph 1976, Tuan 1975).

Due to limitations in sample distribution, this specific research is based on a small sample size compared to all possible broadcast meteorologists in the region who could have participated in this study. At the time of data collection, there were approximately 45 Oklahoma-based broadcast meteorologists who were invited to partake in this work, and nearly half of them agreed to participate (N = 20). We are very fortunate to have their insights and outlooks. Other notable limitations of this study include the geographic extent of spatial analysis; geospatial questions were only held at a county level. While it was clear that broadcast meteorologists held adept knowledge about the counties comprising their DMA, it was hard for this study to distinguish why certain counties were selected over others, as counties can incorporate urban and rural dynamics. Further work should incorporate local-level reasoning, such as municipality level questioning to deduce place-specific attributes. Lastly, we suggest furthering this work to include more designated market areas (DMAs) to see if the trends found in this study persist in other regions.

It is our hope that this discussion of broadcast meteorologists' thoughts and opinions about severe weather coverage and their relations to places within a DMA stimulates new lines of thought and discussion among those who are concerned with improving broadcast meteorologists' communication efforts so they effectively protect those in harm's way regardless of where they live. Severe weather warning communication is an exercise in mutuality – it involves learning about the knowledge and viewpoints of those with whom you are conversing. To this end, a better understanding of broadcast meteorologists' ideas will help prevent and mitigate future disasters and better assist potentially vulnerable populations. By investing time, resources, and commitment to the relationship between broadcast meteorologists and their viewers is critical to providing more effective and usable severe weather communication. More studies are needed to understand the broadcaster's cognitive biases responsible for leading their station's severe weather coverage.

Acknowledgements

The authors are very grateful for Dr. Richard Smith, the Warning Coordination Meteorologist at the National Weather Service – Norman Forecast Office, as he assisted in orchestrating data collection for our survey by using their media list serve. Additionally, the authors extend their gratitude to the 20 broadcast meteorologists who participated in the study for their valuable time and thoughts. Primary funding was provided by the University of Oklahoma's Department of Geography and Environmental Sustainability, as well as the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) Behavioral Impacts Unit.

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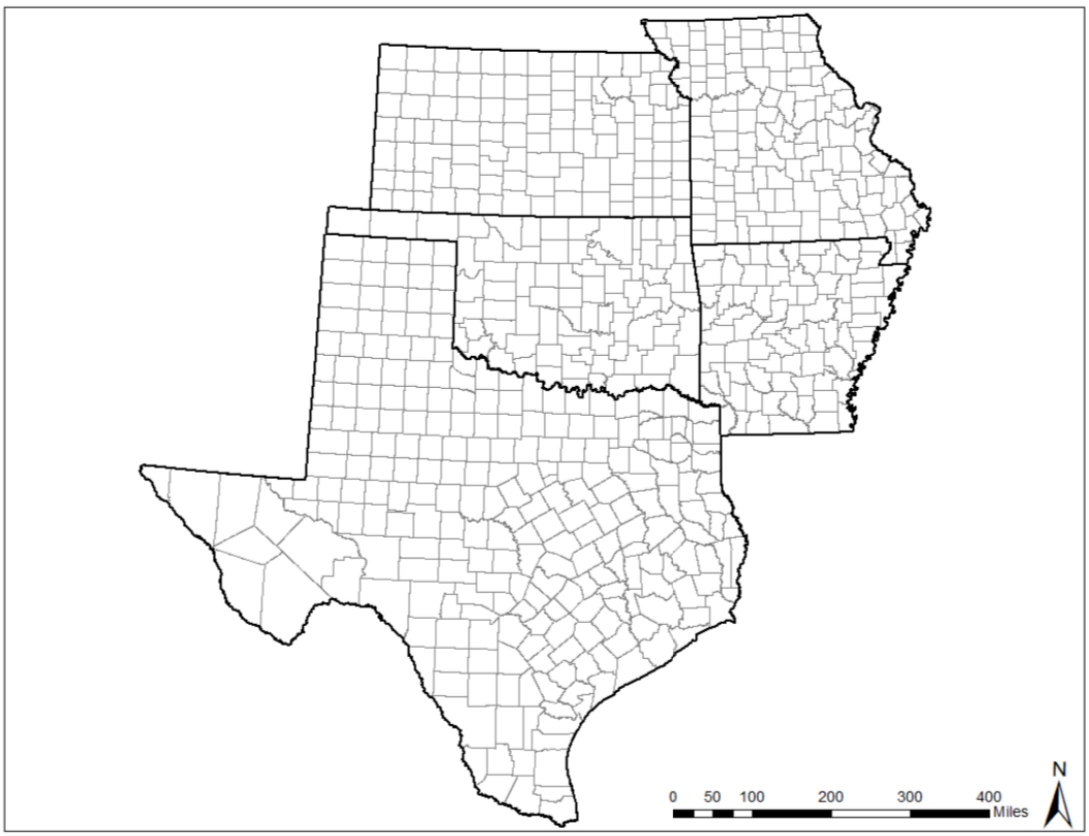
APPENDIX A

Survey Questionnaire – Qualtrics, Web

The questions that follow all pertain to your decisions regarding **live, on-air coverage** for tornado warned storms.

1. For approximately how many years have you been working in a role where you make live, on-air tornado coverage decisions?
2. Approximately how large is the population that you provide weather coverage to?
3. To the best of your ability, please select all of the counties that are within your designated market area (DMA) on the map provided below. To do so, **please click on each county.**



4. In answering the previous question, how confident were you in your ability to fully describe the geography of your DMA?
   - Not confident at all
   - Only a little confident
   - Somewhat confident
   - Completely confident

5. Among the counties you selected, were there any “border” counties – counties you included that may not technically be in your DMA?
   - Yes
   - No
6. During periods of severe weather, has your station worked with a consultant who gave suggestions on your station’s severe weather coverage?
   - Yes
   - No
   - I don’t know
7. Was the consultant ever at the station providing suggestions during live severe weather coverage?
   - Yes
   - No
   - I don’t know
8. Did the consultant provide guidance about the areas you cover during severe weather?
   - Yes
   - No
   - I don’t know
   - If yes, please explain:
9. Do you believe that you station should work with a consultant to provide guidance about the areas you cover during severe weather?
   - Yes
   - No
   - I don’t know
10. Does station management dictate the areas you cover during severe weather?
   - Yes
   - No
   - If yes, please explain:

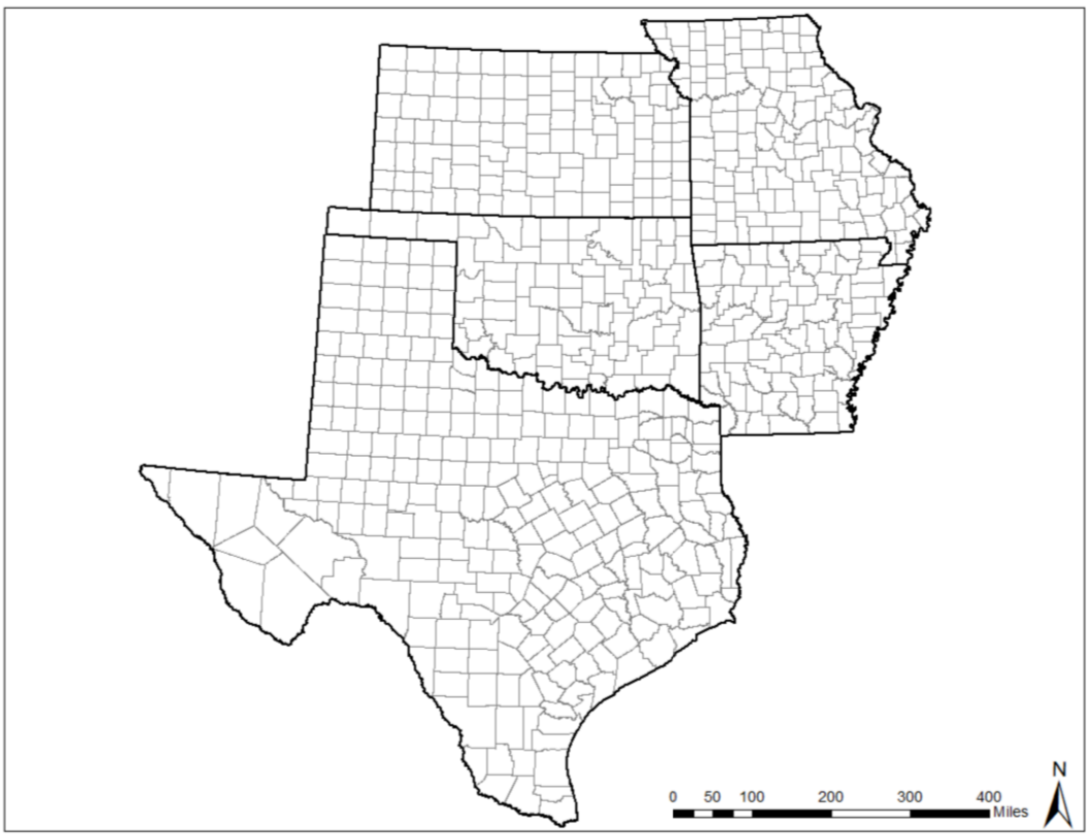
11. At what point does your station *begin* severe weather coverage? **Please select all that apply.**
    - o When the storms are still in neighboring DMAs and are headed our way
    - o When the storms are entering my DMA
    - o When the storms are completely within my DMA
    - o This depends upon the severity of the day (e.g., if storms could be more severe, coverage begins while storms are in neighboring DMAs; if storms are more mild, coverage begins within my DMA)
    - o This depends upon the populations that may be affected (e.g., if storms are headed toward an urban center, coverage may begin sooner)
    - o Other, please describe:
12. At what point does your station *end* severe weather coverage? **Please select all that apply.**
    - o When the storms are leaving, but are still within, my DMA
    - o When the storms are no longer inside my DMA
    - o This depends upon the severity of the day (e.g., if storms could be more severe, coverage continues while storms are moving into neighboring DMAs; if storms are more mild, coverage ends within my DMA)
    - o This depends upon the populations that may be affected (e.g., if storms are heading away from an urban center, coverage may end sooner)
    - o Other, pleas describe:
13. How does your station decide when particular kinds of information are covered during a severe weather event? (e.g., reporting the storms trajectory versus reporting aftermath and damages) **Please select all that apply.**
    - o This depends upon the storm's severity (e.g., once warnings have expired, coverage will report aftermath and damages)
    - o This depends upon the populations that may be affected (e.g., if storms are no longer impacting urban centers, coverage will report aftermath and damages)
    - o This depends upon the storms trajectory (e.g., when storms are along the edge of, or have exited, my DMA, coverage will report aftermath and damages)
    - o Other, please describe:

14. During severe weather events, who makes the decision to interrupt prescheduled television programs to alert the public about severe weather warnings? **Please select all that apply.**
    - The consultant
    - The chief meteorologist
    - The social media manager
    - The producer
    - The news director
    - Other:
15. In your opinion, do you feel that the decisions to interrupt prescheduled television programs are always made at the right time?
    - Always
    - Most of the time
    - About half the time
    - Sometimes
    - Never
16. What are the criteria for making interruptions to television programming for severe weather warnings? **Please select all that apply.**
    - This depends upon the type of warning issued (e.g., tornado warnings will preempt cut-ins; severe thunderstorm warnings will be displayed via radar graphic and/or scrollbar)
    - This depends upon the populations that may be affected (e.g., warnings issued near urban centers will preempt cut-ins; warnings issued away from urban centers will be displayed via radar graphic and/or scrollbar)
    - This depends upon the storm's severity (e.g., storms that pose an imminent threat will preempt cut-ins; storms that are monitored will issue warnings via radar graphic and/or scroll bar)
    - This depends upon the storm's proximity to the market area (e.g., severe storms along the fringes of my DMA will not preempt cut-ins)
    - Other, please describe:

17. At times, your station may choose to cover severe weather events (whether by deploying storm trackers or continued on-air reporting) for counties outside your DMA. What circumstances motivate the decision to include coverage *outside* of your DMA territory?
18. How does your station determine which communities *outside* your DMA receive coverage during a severe weather event?
19. Who at your station determines the communities *outside* of your DMA territory that receive coverage? **Please select all that apply.**
    - The consultant
    - The chief meteorologist
    - The social media manager
    - The producer
    - The news director
    - Other:
20. To what degree do you agree with this statement:
    Severe weather coverage is adequately provided to counties along the *outer edges* (e.g., along the boundary) of my designated market area (DMA).
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
21. How could severe weather coverage improve for counties along the outer edges (e.g., along the boundary) of your DMA?
22. To what degree do you agree with this statement:
    Rural communities *do not* receive adequate cut-ins for a severe weather warning.
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree

23. Do you feel that severe weather coverage focuses on urban communities *more than* rural communities?
    - Always
    - Most of the time
    - About half the time
    - Sometimes
    - Never
24. To what degree do you agree with this statement:
    Severe weather coverage is adequately provided to *all* counties within my DMA.
    - Strongly agree
    - Somewhat agree
    - Neither agree nor disagree
    - Somewhat disagree
    - Strongly disagree
25. Do you feel that the public understands the information contained in severe weather warnings?
    - Completely understands
    - Somewhat understands
    - Does not understand
    - No opinion
26. What are your thoughts about how viewers understand and respond to severe weather coverage?
27. How soon do you think the public would like to know about a potential severe weather threat?
    - A week in advance
    - A few days in advance
    - One day in advance
    - In the moment (less than 4 hours)
28. Describe and/or list the content you feel that the public prefers in your stations live broadcast coverage during a severe weather event.

29. Overall, to what extent do you feel the public is satisfied or dissatisfied with the live broadcast coverage that your station provides during a severe weather event?
    - Extremely satisfied
    - Somewhat satisfied
    - Neither satisfied nor dissatisfied
    - Somewhat dissatisfied
    - Extremely dissatisfied
30. To the best of your ability, please indicate which areas you feel are *more likely* to tune in to your stations live broadcast during a severe weather event. To do so, **please click on each count on the map provided below.**



APPENDIX B

Survey Response Tables

The questions that follow all pertain to broadcast meteorologists' decisions regarding live, on-air coverage for tornado warned storms.

Example Survey Questions **When to Cut-In: Policies and Procedures**	Sample Size *n/20*	Responses
Does station management dictate the areas you cover during a severe weather event?	*9/20*	"Station management is very inconsistent on input of severe weather coverage. Most often input is provided only when there is a perception that coverage may negatively impact revenue."
		"We will only cover border counties if the weather is severe enough and the population is large enough."
		"There are a few counties we will not do wall-to-wall coverage for tornado warnings, and instead we treat their tornado warnings like severe thunderstorm warnings (we only cover them during commercials)."
		"Depending on other programming (live sports, events, etc.), we may cut into programming vs. leave a screen crawl up. Tornado warnings, with very few exceptions, are always cut into programming immediately."
		"We have a designated map for severe weather coverage, meaning, we have highlighted the areas we are confident that our TV signal reaches. We consider those counties to be priority on air live during tornado warnings. We also have 'watch' counties, meaning, no TV coverage is necessary, but we should monitor storms closely in case they move into the DMA."
		"If the severe weather is not in our DMA, we don't cut in except in extreme severe weather situations (moderate- or high-risk days)."
		"The FCC tells us the counties in our viewing area. Station management does not dictate this."
How does your station decide when particular kinds of information are covered during a severe weather event? (e.g., reporting the storms trajectory vs reporting aftermath and damages)	*20/20*	"It is generally left up to the meteorologist but there are times, particularly during certain programs, when management will make coverage decisions and communicate those decisions to staff other than meteorologists."
		"We typically continue tracking and warning if tornado warnings continue. If damage is significant, we may briefly report on the damage as storms continue, but only to enhance communication to seek shelter for those still in the path of the warned storm."
		"This depends upon the populations that may be affected." *(n = 5)*
		"This depends upon the storms severity." *(n = 12)*
		"This depends upon the storms trajectory." *(n = 5)*

Table 3. Survey questions and their associated responses from Oklahoma-based broadcast meteorologists when asked about their decisions to begin or discontinue live severe weather coverage and the kinds of information that are included in their coverage.

The questions that follow all pertain to broadcast meteorologists' decisions regarding live, on-air coverage for tornado warned storms.

Example Survey Questions **Spatial Cognition of DMA Boundaries**	Sample Size *n/20*	Responses
How could severe weather coverage improve for counties along the outer edges (e.g., along the boundary) of your DMA?	*16/20*	"If there wasn't a tendency to lessen coverage after the storms pass larger population centers."
		"Likely would not be considered."
		"Knowing exactly what those 'counties along the outer edges' really are and also knowing what other station is accountable for those counties."
		"It would be improved if we treated them like our main counties - we have been called off air while covering a tornado in our furthest county because the programming was 'too important.'"
		"We track and offer severe weather coverage in our DMA county to county. It's those fringe counties NOT included in the DMA that could be improved by adding them to our DMA."
		"If we have a huge weather event impacting western and central Oklahoma, often we focus on damage in the Metro more than focusing on warnings pushing into our eastern fringe of our DMA."
		"I think we do a pretty adequate job making sure those areas on the fringes of our DMA are covered properly. We cut in anytime those areas are looking at threatening weather headed their way, even if it won't affect our major population centers."
How does your station determine which communities outside of your DMA receive coverage during an event?	*17/20*	"Mainly, if a tornado warned storm is nearing the DMA, or if a significant tornado is moving through an urban area, such as the OKC metro."
		"Typically, we do not cover any of the communities outside of our DMA. However, if a storm becomes severe outside of the DMA and is moving into our border counties, we will start to cover the storm via social media."
		"We judge this based off the severity of the storm and the population of the communities."
		"Over the years, we've received communication from residents in certain communities in our fringe area counties that feel they are 'in-between stations' from one DMA to the other. We try to fill that gap by at least communicating tornado warning information on air. Of course, we reinforce this information using social media platforms."
		"The news director, producers, and anchors will communicate with the chief meteorologist on the need to provide additional coverage to counties outside the DMA."

Table 4. As in Table 3, but broadcast meteorologist's responses when questioned about geospatial aspects of their designated market area (DMA), such as how particular counties are selected to be included in their severe weather coverage and how such coverage could improve for certain

The questions that follow all pertain to broadcast meteorologists' decisions regarding live, on-air coverage for tornado warned storms.

Example Survey Questions **Perceptions of Viewer Needs and Knowledge**	Sample Size *n/20*	Responses
What are your thoughts about how viewers understand and respond to severe weather coverage?	*15/20*	"I believe our viewers have some of the highest meteorological and severe weather knowledge in the country. That being said, some people are confused by certain warnings and watches. I believe that most Oklahomans know where to go during a tornado. However, there is a social science element - for example, if people are traumatized from a previous severe weather event, they may act irrationally and flee from a tornado instead of sheltering in place." "I legitimately think there are some people that don't understand where they are on a map compared to major population centers (i.e., Tulsa) that hurt their ability to discern if storms are headed their way or not. Otherwise, I think most of the public is pretty well versed in severe weather terminology and readiness and knows how to get information." "Our viewers are very weather savvy and appreciate our weather coverage when severe weather moves in. They understand velocities, hail sizes, and wind gusts pretty well. The biggest thing they struggle with is geography and knowing where certain towns and counties are in comparison to their location." "I believe most viewers understand and respond well to severe weather coverage. They have become accustomed to how we cover severe weather and know how serious a situation may be based on how we are covering the storm." "People seem to be very self-centered. If severe weather hits them it 'came out of nowhere' despite days of accurate forecasting and constant severe weather updates. If they aren't being affected, we get calls about how we 'just want to stroke our own ego.' Severe weather seems to be held as another nuisance thing that people don't pay attention to until it's too late."
Describe and/or list what content you feel that the public prefers in your stations live broadcast coverage during an event?	*17/20*	"They like visuals of the storm along with street-by-street radar coverage. They also want the meteorologists to reference other strong storms that will still be a nuisance, especially if near an urban center. Damage shots are also sought following a storm during our coverage." "Viewers seem to rely on our experience, our tools and capabilities. We have a very large storm tracker presence in the field during almost all severe weather events if possible. Our entire company is focused to offer the best severe weather information possible." "People like calm and concise, not overly inflated or scary." "Video, estimated time of arrival, street-level mapping, clear and accurate communication that is not overhyping the storm, impacts, and experience." "The most important thing I think is the storm track because that's what they all care about. 'When will it get to my house.'"

Table 5. As in Tables 3 and 4, but broadcast meteorologist's responses when questioned about their perceptions of their viewer's needs, knowledge, and understanding of content contained within their severe weather coverage.

CHAPTER 4

CONCLUSIONS

This paper provides a number of contributions to our understanding of how broadcast meteorologists communicate severe weather warnings during a tornado outbreak. Previous research on broadcast meteorologists live, continuous wall-to-wall coverage, such as the sources cited throughout this paper, generally focus on tools used to enhance on-air coverage, such as elements included in the videography process that help broadcasters further clarify severe weather risks across geography in real-time (Klockow-McClain et al. 2019, Zhao et al. 2019, Cario 2016, Drost et al. 2016, Nagele and Trainor 2012, Wei et al. 2010, Daniels and Loggins 2007). These studies tend to incorporate some investigation into media exposure by examining the influence of cartographic warning displays on public risk perception and response. Complementary studies find new, improved and different ways to enhance broadcast meteorologist's warning communication by examining how they can make messages more effective and get more people to respond appropriately upon receiving the message (Reed and Senkbeil 2020, Walters et al. 2020, Sherman-Morris et al. 2018, Ebner 2013). Some of these studies introduce potential systemic issues of representing different geographies and find that linguistic, ethnic, and racial differences significantly influence the extent to which one can receive and understand information conveyed in the warning message (Doyle 2016, Ahlborn et al. 2012, Burke et al. 2012, Donner et al. 2012, Senkbeil et al. 2012). Apart from this, few studies examine broadcast meteorologists and their decisions for providing coverage to particular locales (Cario 2016, Ebner 2013). These studies indirectly find that broadcasters delineate particular places as geographical focal points during their live coverage and that certain places receive disproportionate levels of coverage based upon where they live.

While some research suggests that geography poses significant barriers in how warning messages are distributed and received, no research has considered this from the perspective of broadcast meteorologist's spatial knowledge of designated market areas (DMAs). This paper, therefore, took a unique approach to understand why broadcasters shift their geographic focus by questioning the factors involved in their decision-making process, such as how they decide to begin or discontinue live coverage based upon their familiarity with their DMA and their assumptions about the communities within them. In doing so, this paper expands upon the existing discourse by integrating qualitative Geographic Information Systems (qGIS) to thoroughly examine how one's spatial cognizance affects the consistency and adequacy of their live severe weather coverage. Mapped representations provided a unique way of visualizing how broadcast meteorologists' perceptions of place facilitate decision-making for reporting particular geographies. This contribution is especially important because of how vital broadcasters are in the severe weather warning process and persuading the public to take proper actions during dangerous severe weather events.

This work proposed that places across a DMA, particularly areas that are less populous, rural, and between two DMAs, do not receive the same level of time and attention spent covering active tornado warnings than more populous, urban towns. Based on findings from surveying Oklahoma-based broadcast meteorologists from three of Oklahoma's DMAs – Oklahoma City, OK, Tulsa, OK, and Wichita Falls, TX – Lawton, OK – broadcasters seemed to acknowledge this inadequacy. They professed various ways of disseminating warning information that stemmed from their understanding of urban and rural communities. When deciding to provide severe weather coverage, such as when to begin or discontinue their live, continuous wall-to-wall reporting, broadcasters stated that they rely on their perception of the storm's intensity and trajectory within their DMA, as well as their understandings of the populations that may be affected. In this case, broadcasters admitted to providing coverage for large urban metropolitan areas more than nearby less populous rural towns. This decision meant that broadcast meteorologists focused more heavily on counties central to their DMA than counties along the outer edge of their DMA, as these denote the majority of Oklahoma's rural communities. Furthermore, they specified that extended coverage into rural areas along the border of the DMA only took place when storm activity was perceived to be particularly dangerous and capable of producing numerous dangerous tornadoes.

A broadcast meteorologist's decision to provide live severe weather coverage is not always solely left to the meteorologist working at the time. Sometimes, broadcasters mentioned receiving input from other non-meteorological members like news producers, directors, and station management. This input was most often provided when there was a perception that coverage would negatively impact revenue. Therefore, the decision to provide severe weather coverage was largely dependent on the type of programming on-air at the time. For example, popular TV shows and sporting events most often meant that broadcasters would resort to dissemination methods that did not require interrupting programming. In these cases, warning messages were presented through text scroll bars and bugs positioned at the bottom corner of the television screen. These observations have direct effects on risk communication and the ability for people to protect themselves during a dangerous severe weather event.

This study also found that broadcast meteorologists relied on their spatial understandings of communities comprising their DMA to aid in deciding when to begin or discontinue live severe weather coverage. Building upon methods proposed by Cope and Elwood (2009), Knigge and Cope (2006), this study employed qualitative GIS to provide mapped representations of broadcasters' interpretations of the counties they understood to be within their DMA, as well as counties thought as being more likely to view their coverage. These illustrations were useful because they highlighted how their understandings of place influenced the areas they chose to emphasize in their live coverage. This analysis suggests that broadcasters are well-versed and spatially cognizant of the places within their viewing market but believe most of the viewing audience exists in the most central portion of the DMA, which is usually centralized around large urban metropolitan cities. In fact, broadcasters even admitted to focusing on counties with larger population densities and confessed to being called off air for covering storms affecting smaller populations along the outer edge of their DMA. Therefore, this study underscored that the decision to provide adequate and consistent coverage throughout the entirety of a DMA depended upon their knowledge and opinions about certain geographical groups.

Broadcast meteorologists alter their decision-making processes based on their notions of what their viewers can understand. Given that this was an Oklahoma-case study, broadcasters described their viewers as being exceptionally weather aware due to the state's unique climatology and frequent experience with severe storms. Intriguingly, while broadcasters described their viewers as being weather savvy, they also believed their viewers struggled to spatially depict the storms trajectory relative to their location. To rectify this, broadcasters provide a geographic scope for discussing elements of the tornado outbreak as the severe weather moves over portions of the DMA. They also tailor content to individuals at a local level when communicating warning information and mention affecting cities, landmarks, streets and street intersections. On the other hand, broadcasters will take a wider perspective and discuss the overall storm system to alert residents ahead of the storm and in its path. They also mentioned the importance of maintaining calm to avoid sensationalizing and overhyping the severity of a storm threat.

Overall, this research expanded our understanding of spatial risk decision making and resonates well within geographical studies of media and communication (Adams 1992, Adams and Janson 2012). The range of theoretical concerns in this body of work includes television's performance, materiality, networks, emotions and affect, all of which directly influence the quality and scope of a broadcast meteorologist's severe weather coverage. Collectively, these concerns point to communications not merely as transmissions through infrastructure, space and time, but rather as encounters between various human and nonhuman agents. In this sense, a broadcast meteorologist's televised severe weather coverage provides such a place for residents to congregate and receive critical information about a storm's impending threats. However, the way in which broadcasters choose to disseminate information about particular locales inflect potential opportunities or limitations for certain residents within a designated market area (DMA) to receive appropriate coverage. Given that broadcast meteorologists take on a leading role as risk communicators, they are important for transmitting risk images of space and place through multiple technological platforms during severe weather events. This study highlighted nuances in a broadcast meteorologist's decision-making process and how they come to transmit their message geospatially.

Broadcast meteorologists readily draw upon their understanding of geography, particularly their interpretations of space and place, to assist in disseminating severe weather warnings. Investigations into the multifaceted intersection between broadcast meteorologist's perception of space and place with respect to their designated market area (DMA) are underpinned by numerous works, especially by Tim Cresswell (2015), Edward Relph (1976), and Yi-Fu Tuan

(1975). These geographers proposed that people develop specific attitudes and feelings about a place with regard to the geographical areas in which they live. Specifically, Relph (1976) and Tuan (1975) explain that one's deep emotional feelings to place can sway their decisions, influence actions, and shape their perspectives. Therefore, our findings insinuate that broadcast meteorologist's geospatial relationships with their DMA, such as their understanding of inherently spatial DMA boundaries and their interactions with the places within them, influence their decision to provide coverage and the locales they choose to include in their coverage. Here, we find that place-based perceptions explain why the focus on urban towns more so than nearby rural places, which is because they believe these places are more populous.

Potential limitations to findings in this paper are due to the sample selection and methodology. First, the analysis is based on a small sample size compared to the entirety of broadcast meteorologists in the study region. At the time of data collection, approximately 45 broadcast meteorologists could have participated in this work, and only 20 agreed to contribute. Additionally, GIS analysis visualizing broadcaster's knowledge and perceptions of their respective DMA was held at a county level. While it is clear that broadcasters held adept knowledge of the communities throughout their DMA, it is hard to deduce conclusive reasoning as to why certain county selections were made over others. Future work will benefit from incorporating local-level reasoning when questioning broadcasters' opinions about geographic focal points in their coverage, as there are many urban and rural communities embedded within particular counties. Future work might also consider examining broadcast meteorologists' decisions for providing live severe weather coverage during a notable severe weather outbreak (e.g., moderate- or high-risk) and compare it to their decisions when there are events that are less severe. How would the structure, quality, and content of a broadcast meteorologist's severe weather coverage change if several catastrophic tornadoes had taken place throughout the region versus when there were not? Lastly, further research should expand this study to incorporate more broadcast meteorologists from additional DMAs to see if the discoveries shown here appear in other places as well. Overall, the findings presented in this paper are not meant to be generalizable but functions as an exploratory study of the primitive role of broadcast meteorologists from their point of view.

Taking into consideration the limitations, findings from this paper resonate with recommendations for enhanced media performance during severe weather outbreaks. These include consistent messages delivered from a credible source that continue throughout the entirety of a severe weather event regardless of populations affected. Broadcast meteorologists in this study expressed that their televised tornado coverage continually addressed and updated residents over the course of the tornado outbreak but fell short as storms approached less populated places near the margins of their DMAs. A better understanding of the ideas held by broadcast meteorologists will help prevent and mitigate future disasters and better assist potentially vulnerable populations in between DMAs.

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