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The Educational Training of Storm Chasers and Storm Spotters in Relation to Geographical Dispersion Across the United States

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ABSTRACT

When severe weather strikes, storm chasers and storm spotters confirm that what forecasters and meteorologists are seeing on a radar screen is actually occurring in the field. While some documenters are classically trained (i.e. they have a background in atmospheric science and or meteorology attained from a 4 year university) many others are not. There are currently two organizations available for the weather enthusiast to be a part of, SKYWARN and SpotterNetwork. These organizations give weather enthusiasts a background knowledge into severe weather; however, many weather enthusiasts are not classically trained and most have not taken any formal education in the fields of atmospheric science.

By creating a survey questionnaire the differences in educational training, as well as an analysis of the numerous aspects and characteristics of a severe weather observer, was documented to discern if this training had any effect on their geographic distribution during severe weather events.

Using the statistical tests Chi-Squared, ANOVA (Analysis of Variance), and Correlation Analysis, the results from the survey questionnaire were analyzed. Chi-Squared analysis was used to examine if any of the variables (questions asked on the survey) were relatable to a severe weather documenter having a four year degree in atmospheric science and or meteorology. ANOVA examined the statistical relationship between a severe weather documenter's confidence level in his or her background knowledge in atmospheric science versus their educational background. Correlation analysis examined if a severe weather documenter's confidence in their background of

atmospheric science knowledge, as well as their education level, influenced their range of travel during severe weather events.

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1. INTRODUCTION

Thunderstorms impact thousands of people every year in the United States; from the East coast to the West coast and everywhere in-between. Damaging winds, hail, downbursts, lightning, flash floods, and tornadoes are all hazards associated with thunderstorms, most notably severe thunderstorms (Doswell, 2003). Defined as a storm that produces lightning and thunder, thunderstorms are observed in most regions of the world (Lutgens, Tarbuck and Tasa, 2009). Worldwide, there are approximately 16 million thunderstorms each year, with roughly 2,000 thunderstorms occurring at any given moment (NSSL, 2012).

When severe weather strikes, the task of confirming that what forecasters and meteorologists are seeing on screen is actually occurring in the field relies on the numerous severe weather documenters spread throughout the United States. By collaborating with forecasters and meteorologists, these severe weather documenters can confirm that what is seen on the Doppler radar image is actually occurring in the field (Andra, Quoetone, and Bunting, 2002). This passion for documenting, reporting, and or following severe weather is shared by a unique group of people across the United States. The individuals who risk their lives and property for the betterment of science, termed storm chasers and storm spotters, operate in the extreme and applied fields of meteorology, atmospheric science, and severe weather science.

By definition, a "Storm Chaser" and or a "Storm Spotter" is a person who documents severe weather as it occurs. While both storm chasers and storm spotters observe and document severe weather, there are fundamental differences between the two. Defined as someone who observes and follows a developing thunderstorm either for educational purposes, scientific research, or as a recreational activity; storm chasers have unique history in the science of meteorology (Robertson, 1999). A storm spotter is defined as a volunteer or paid county or municipal employee who documents severe weather as a community service (NWS, 2007).

Every year the technology to track and forecast severe weather improves (Johnson, 2000). These advancements have helped usher severe weather documenters into the mobile hand-held era, an achievement once only dreamed about. Not only is technology improving, the training and education available for individuals interested in documenting these severe storms is improving as well. Unfortunately, there is still one major shortcoming in the field of severe weather documentation. This shortcoming is the range and geographic dispersion of storm chasers and storm spotters. While storm chasers and storm spotters are present in every state throughout the United States, the majority reside in the southern states (Oklahoma, Texas, Alabama, Mississippi, Kansas, etc.). Here-in lies the problem. If severe weather occurs outside of this clustered area how many of these storm chasers and or storm spotters, if any, are willing to travel large distances to document these storms?

The purpose of this research was to examine the education gained by these storm chasers and storm spotters and discern if this training had an effect, if any, on their geographic distribution in the United States. The hypothesis for this research project was that storm chasers and storm spotters who hold a four year degree in the field(s) of atmospheric science and or meteorology are more willing to travel across the United States to locate, document, report, and possibly follow severe weather. Likewise, storm chasers and storm spotters not knowledgeable in the field(s) of atmospheric science and or meteorology, who gained their education through an organization (i.e. SKYWARN, SpotterNetwork, etc.), tend to stay isolated in one geographic area.

By examining this hypothesis, the educational background of severe weather documenters (i.e. storm chasers and storm spotters) could be examined as the possible influence of geographical distribution and movement throughout the United States during the severe weather season. For this study two differences in education were examined. These differences include: a) a formal multi-year disciplinary education gained in a university setting, and b) a brief education gained through an online setting or informational meeting.

The findings of this study can usher in a major paradigm shift for the primary educators of storm chasers and storm spotters: the National Weather Service (NWS) and its parent organization the National Oceanic and Atmospheric Administration (NOAA). If the hypothesis of this study proves correct, this study will offer insight on how to better train these severe weather documenters to be better prepared for when severe weather strikes. This new training would then translate into better collection of field data and safety practices.

2. LITERATURE REVIEW

Tornado Alleys

The United States averages approximately 100,000 thunderstorms annually with roughly 10% of these thunderstorms becoming severe (SpotterNetwork, 2012A). This high frequency makes the United States the number one country in the world for severe thunderstorm occurrences. A severe thunderstorm is defined by the National Weather Service (NWS) as a thunderstorm that produces either one inch diameter sized hail (or greater), wind gusts of 58 miles per hour (or greater), or a thunderstorm that produces a tornado (NSSL, 2012). Depending on the variables and calculation methods, the areas known for severe thunderstorm and tornado development can shift dramatically across the country from the Rocky Mountains to the Appalachian Mountains (Dixon *et. al*, 2011). Most thunderstorms seen in the United States occur across the Florida Peninsula where tropical factors influence their development. While the Florida Peninsula experiences the highest frequency of thunderstorms and tornadoes, most storms in this area are typically short lived and less violent compared to other regions of the United States. Currently, there is evidence that multiple alleys of tornado activity exist across the United States. These regions include the Great Plains (commonly referred to by its nickname "Tornado Alley"), several states in the southeastern portion of the country (referred to as "Dixie Alley"), the region near the Ohio/Indiana border (also known as "Hoosier Alley"), and the region encompassing parts of Georgia, South Carolina, and North Carolina (termed "Carolina Alley") (Ashley, 2007).

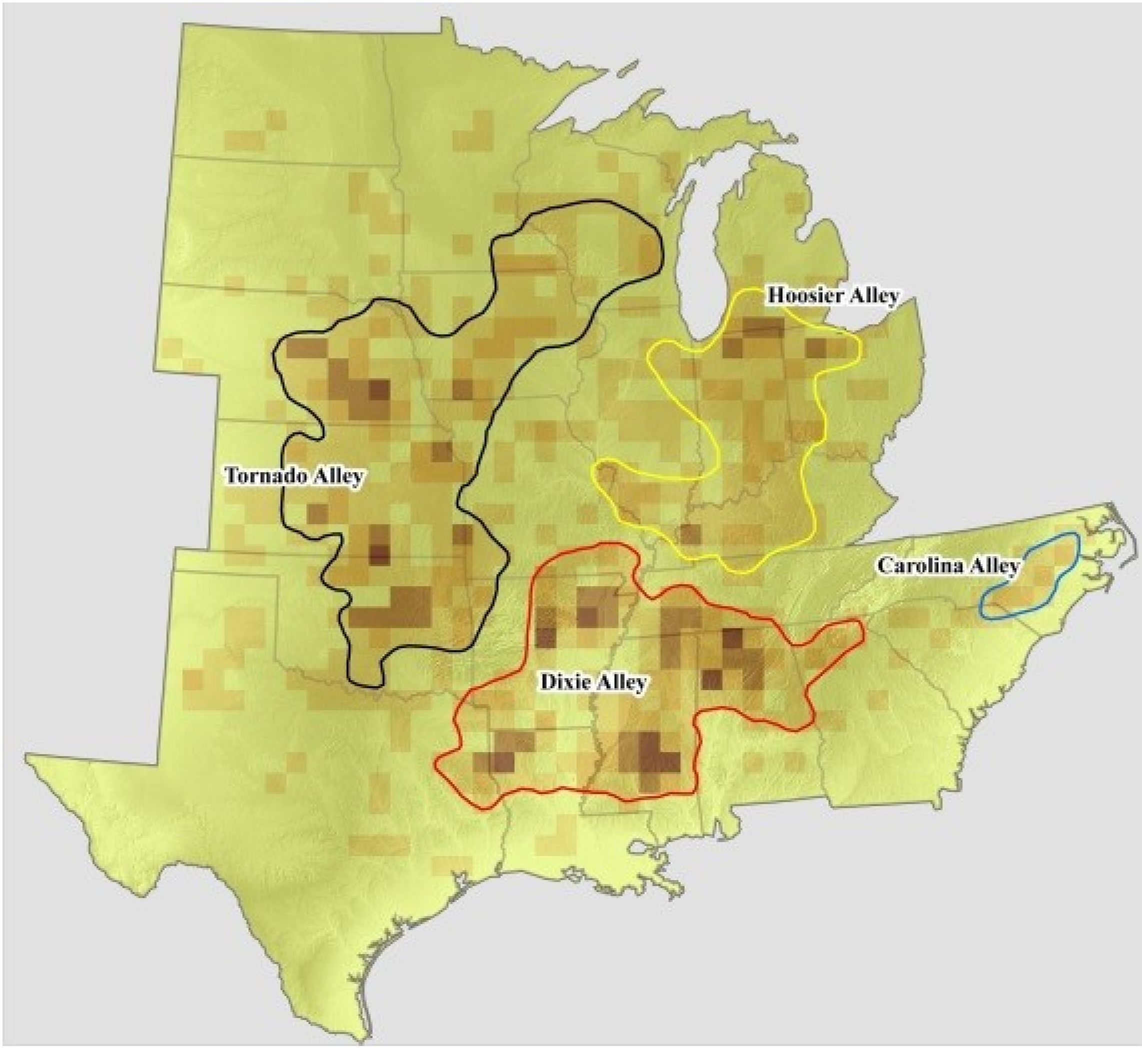

Figure 2.1 A map showing one example of the four distinct "Tornado Alleys" in the United States (Frates, 2010).

Tornado Alley

The Great Plains region is known for having some of the most severe thunderstorm and tornado outbreaks compared to anywhere else on Earth (Robertson, 1999). Noted in popular culture movies such as *The Wizard of Oz* (1939), *Mr. and Mrs. Bridge* (1990), and *Twister* (1996) the Great Plains region is iconic for its severe weather. Including the states of Iowa, Oklahoma, Nebraska, Kansas and Texas, the Great Plains, more commonly known by its nickname "Tornado Alley", is one of four geographic hotspots for severe thunderstorm and tornado development. The result of mid-latitude factors, Tornado Alley has gained its notoriety from its high frequency of severe thunderstorms and tornadoes resulting from the influx of warm, moist air from the Gulf of Mexico colliding with cold, dry air from the northern latitudes. This collision results in the atmosphere becoming unstable, creating a prime environment for thunderstorm and tornado development (Ahrens, 2006). As noted in the later section (Severe Weather Documentation), this region has become the focus of the most intensive storm chasing activity in the United States (Robertson, 1999).

Tornado Alley is noted for observing strong and violent tornadoes during its storm season between the months of April and June; in fact, approximately 72% of all tornadoes in Tornado Alley occur during this three month span (Gagan, Gerard, and Gordon, 2010). One aspect that makes this tornado alley unique is the time of day when most tornadoes occur. Approximately 76% of all strong and violent tornadoes occur during the afternoon and early evening hours from 12 PM to 9 PM (Ashley, 2007; Gagan, Gerard, and Gordon, 2010). Compared to the other tornado alleys, the characteristics of the Great Plains region includes more visible daytime tornadoes, in part due to a lack of trees; a low percentage of vulnerable mobile home stock; a smaller population density; and greater history and experience with severe thunderstorms and tornadoes, leading to more awareness of what to do during a tornado outbreak (Ashley, 2007).

Dixie Alley

Between the years 1880 and 2003 the highest frequency of violent long tracking F3 to F5 tornadoes of any region in the United States occurred in the lower Mississippi and Tennessee Valleys (Broyles and Crosbie, 2004). This region, termed "Dixie Alley", is historically noted for long tracking storms and violent tornadoes. The result of warm, moist air from the Gulf of Mexico colliding with dry air from the deserts of Arizona, New Mexico, and west Texas, this interaction between warm and dry air masses allows the Dixie Alley region to experience severe thunderstorms and tornadoes in the fall, winter, and spring months of the year (Melhuish, 2012). Due to the southerly movement of the jet stream, Dixie Alley does not typically experience many tornadoes in the summer months.

Compared with the Great Plains tornado alley, Dixie Alley is a much more violent and unpredictable environment. According to Gagan, Gerard, and Gordon (2010) and Ashley (2007) Dixie Alley has a 50% greater risk of strong tornadoes during the overnight hours compared to Tornado Alley, with over one third of its killer tornadoes occurring between the hours of 9 PM and 7 AM. Additionally, 40% of the strong and violent tornadoes experienced in Dixie Alley have occurred during the months of October through February, compared with only 10% in Tornado Alley during that time (Gagan, Gerard, and Gordon, 2010).

Hoosier Alley

Beginning in late spring and extending into early summer, the region from southern Michigan to southern Indiana, and eastern Illinois to western Ohio becomes a hotspot for severe thunderstorm and tornado development (AccuWeather, 2012). This tornado alley, dubbed "Hoosier Alley", is relatively new in the fields of severe weather science and meteorology. Though typically not as active as the other tornado alleys (Tornado Alley and Dixie Alley), Hoosier Alley is the one of the last places a tornado can begin to develop before the Appalachian Mountains in Pennsylvania and West Virginia detour the wind speed generation needed for severe thunderstorm and tornado development (Broyles and Crosbie, 2004). A result of jet stream fluctuations, Hoosier Alley is not as active as Tornado Alley and Dixie Alley until the spring and early summer months.

Carolina Alley

Research conducted in the last several years has acknowledged a possible fourth tornado alley in the United States. Beginning in northern Georgia and extending through the top of South Carolina toward the coast and northeastern part of North Carolina, this new tornado alley, termed "Carolina Alley", is less known compared to Tornado Alley and Dixie Alley, though just as deadly and destructive (Broyles and Crosbie, 2004). Most of the severe thunderstorms and tornadoes in this region are the result of mid-latitude factors during the spring months and the numerous thunderstorms comprising tropical cyclones during the summer and fall months (AccuWeather, 2012).

This region, albeit not widely recognized for tornado outbreaks, has the highest frequency of long path F3 to F5 tornadoes east of the Appalachian Mountains with 9.4 per 1,000 square miles (Broyles and Crosbie, 2004). Since 1990, North Carolina has averaged approximately 16 tornados per year with South Carolina averaging roughly 28 per year. In 1998, North Carolina experienced a record 66 tornadoes. The record for South Carolina stands at 54 in 1995 (AccuWeather, 2012). Although the region has not experienced an EF5 tornado in recent years, the threat is always a strong possibility. Because this idea of a Carolina Alley is relatively new in the field, there is limited literature on the subject. Hopefully, in the coming years, more literature will be available to provide more detail on this new tornado alley.

Severe Weather Documentation

In order to observe and learn about severe weather it is imperative that thunderstorms, especially severe thunderstorms, be intercepted and observed. Because thunderstorms are typically mobile, the chances of observing a thunderstorm and the hazards associated with them is quite small as thunderstorms are typically isolated and affect small geographic areas. This idea that severe thunderstorms should be intercepted and observed led to the first organized programs dedicated to the study of severe thunderstorms back in the late 1960s and early 1970s (Bluestein, 1999). Prior to the early 1970s, what was known about severe thunderstorms and tornadoes came from eyewitness accounts and from outbreak events near radar sites. Before the introduction of these interception and observation programs, very little was known about the structure and behavior of severe thunderstorms and tornadoes. To scientists like Dr. Tetsuya Theodore

Fujita the findings of these research monitoring programs helped prove some of his hypothesized theories. One example was Fujita's work on severe thunderstorm and tornado terminology of storm architecture, much of which is still in use today (Fujita, 1960).

History: 1970s

Beginning in the late 1960s, the National Severe Storms Laboratory (NSSL) began a Tornado Intercept Program with the goal of intercepting tornadoes by using armored tanks (Bluestein, 1999). By using mobile automobiles instead of tanks, researchers were able to better intercept severe storms during the study period. Apart from the plethora of photographs and videos captured during the observations, the main result of this early program was the establishment of the methodology for intercepting a severe thunderstorm. This method has remained largely unchanged since its inception roughly 40 years ago. The intercepting of a severe storm begins early in the morning with the identification of a geographic area which has a high probability of experiencing severe weather. This identification is based on morning surface, sounding, and model data (Robertson, 1999). After identifying a prime location, documenters arrive in the targeted area before storms begin to form. When storms begin to develop, documenters must travel to the exact area and attempt to position themselves approximately one to three miles in front and to the southern portion of the anticipated path of the storm's wall cloud or updraft base (Bluestein, 1999). This area is largely considered the most likely region of tornadic development in a supercell thunderstorm (Brooks, 1951). This range of distance typically allows a documenter to safely observe a tornado without the danger from airborne debris or large hail. One frustration quickly realized during this program was that the further a documenter was from a radar site, the more difficult it was to correlate *in situ* data with that of radar data.

While documenters were in the field observing, recording pictures and video, and taking *in situ* measurements of severe thunderstorms, a meteorologist at the NSSL headquarters coordinated information to those in the field. This meteorologist, termed a "nowcaster", provided documenters with up-to-the minute surface observations, interpretation of satellite data, short-term forecasts, and radar information (Bluestein, 1999). To maintain contact with the field documenters, radio contact was made with the aid of a repeater located atop an instrumented television tower in northeast Oklahoma City. Communication was also established by using radiotelephone or by simply using a pay phone.

History: 1980s

After developing a methodology to safely intercept severe thunderstorms and tornadoes, officials at the NSSL decided to incorporate advanced scientific equipment into the field to collect *in situ* data via instruments carried in documenter vehicles. In 1980, Al Bedard at the Wave Propagation Laboratory in Boulder, Colorado along with Howard Bluestein at the University of Oklahoma at Norman constructed a 400 pound instrument package named TOTO (Totable Tornado Observatory) after the dog in the 1939 movie *The Wizard of Oz*. TOTO was designed to be transported via pickup truck and deployed in approximately 30 seconds into the path of an oncoming tornado (Bedard and Ramzy, 1983). The implementation of TOTO began in the summer of 1981 with the overall goal to collect measurements of wind speed, wind direction, pressure, temperature, etc. and record these measurements on paper strip charts (Bluestein, 1983; Bluestein, 1999). Although TOTO was never placed directly into a major tornado, TOTO was placed under several wall clouds. One result of using TOTO in the field was the discovery that the barometric pressure under a wall cloud was typically 2–5 millibars less than the surrounding atmosphere (Bluestein, 1983). In 1985, the TOTO project was abandoned after it was discovered that high speed winds could tip the instrument over before any data collection began. Tests conducted at Texas A&M University's wind tunnel revealed that wind speeds of approximately 110 miles per hour, much less than the maximum wind speed in many violent tornadoes, could topple the instrument onto its side. Incidentally, TOTO was the inspiration for the device named "Dorothy" in the 1996 Hollywood movie *Twister* (Bluestein, 1999).

Around the same time as the conclusion of the TOTO project, researchers began releasing portable radiosonde weather balloons into the updrafts of severe thunderstorms. Using a system developed by Atmospheric Instrumentation Research in 1984, radiosondes were successfully released underneath the wall clouds of several supercell thunderstorms in Texas (among other locations) in 1985, 1986, and 1987 (Bluestein *et al*. 1990a; Bluestein *et al*. 1990b). The results of these radiosonde launches were quite surprising and ground breaking in the field of meteorology. One result showed that several tornadic supercells possessed an updraft speed of nearly 110 miles per hour (Bluestein, 1999). The reason for this incredible updraft speed was found to be what scientists termed parcel theory. Parcel theory assumes that an air parcel retains its shape and general characteristics as it ascends (and descends) in the surrounding atmospheric environment. This theory also explains that when an air parcel ascends (and descends) through the atmosphere the parcel will warm (and cool) compared to the surrounding air at the same pressure elevation (Gray and Thorpe, 2001). It was discovered that parcel theory, along with the latent heat release from the freezing of super-cooled water drops, and upward-directed perturbation-pressure gradient, the enhancement of the updraft due to the dynamic lows within pulling surrounding air into the updraft, were found to be the significant forces contributing to the tremendous updraft speed in supercell thunderstorms (Weisman and Klemp, 1984).

As mentioned previously, much of the knowledge gathered on severe thunderstorms and tornadoes came from chance instances when a storm would pass by a radar site. For years researchers had been interested in creating a reliable, sturdy portable radar dish capable of traveling into the field with documenters with the goal of capturing radar data during severe weather outbreaks. Scientists proposed that a higher resolution image could be attained if a portable radar was transported and placed close to a severe thunderstorm or tornado. By using a portable radar, scientists would be able to scan the area much closer to the ground compared to a traditional radar site many miles away. This portable radar would increase the number of datasets while also increasing the sensitivity to the highest wind speeds in these severe storms. Coupled with ground visual documentation, portable radar would add a new dimension into studying severe storms.

In 1986, technicians from Texas Instruments made available to researchers a portable, 3 centimeter wavelength, continuous-wave Doppler radar from the Los Alamos National Laboratory (LANL) (Bluestein, 1999). The LANL radar was a low-power, battery-operated, solid-state, portable version of the first meteorological Doppler radar used to collect wind spectra from a 1958 tornado in Kansas (Brown and Lewis, 2005). After upgrading the LANL radar, researchers and operators were able to monitor and record base velocity data in real time. Base velocity, the approaching and receding spectra in regards to a radar site, was previously recorded separately then manually combined into one image (Whiton *et. al*, 1998). This feature allowed operators to analyze base velocity data in real time to better position documenters in the field. Beginning in 1987, with support from the NSSL during the Doppler/Lightning (DOPLIGHT '87) project and the National Science Foundation (NSF), the LANL radar was taken into the field to record data on severe thunderstorms (Bluestein, 1999).

Between the storm seasons of 1990 and 1991, LANL radar data, coupled with the efforts of field documenters and support from the NSSL and the NSF, made several important discoveries about the characteristics of tornadoes (Bluestein, 1999). One discovery was that the thermodynamic speed limit of tornadoes, originally thought to be approximately 100 meters per second, can be marginally exceeded in large, violent tornadoes (Snow and Pauley, 1984). Another important discovery was the confirmation of F-5 wind speeds in a tornado. F-5 wind speed intensities had previously been indirectly estimated using photogrammetric analysis of debris videos and by examining damage caused by tornadoes after the incident by Fujita in 1981. A third discovery made by the LANL radar was the measurement of relatively high wind speeds in a tornado while in its rope-out stage (near the end of its life-cycle). The combination of portable Doppler radar with that of field experiments helped usher scientists into an new age of thunderstorm and tornado understanding. Unfortunately, when the LANL radar was brought into the field, operators quickly noticed some disadvantages to the system. One big disadvantage was that the resolution of the Doppler radar was too low to resolve the substructure of the wind field in tornadoes. With the radar's 58 beam width antennas, its cross-beam resolution could stretch 1,000 feet or more at safe distances from a tornado, even though its along-the-beam resolution in its Frequency Modulated Continuous-Wave mode was only 250 feet (Bluestein, 1999). To attain finer resolution in the cross-beam direction, larger antennas would need to be installed. Unfortunately, adding larger antennas would have rendered the system less portable or not portable at all and in 1995, after eight years of service, the LANL Doppler radar was decommissioned.

History: 1990s

During the spring of 1994 and 1995 a new research experiment was initiated in order to test hypotheses concerning tornadogenesis, tornado dynamics, kinematics, and how the environment regulates storm structure. Termed Verification of the Origins of Rotation in Tornadoes Experiment, or VORTEX, this experiment coordinated a multiplatform, storm intercept, field experiment in the southern plains (Rasmussen et al. 1994). The first intercept experiment was focused on making decisions involving the placement of equipment in the field by someone in a mobile vehicle, rather than back at the NSSL or the University of Oklahoma. A number of new observing systems were tested, while other older systems such as the National Oceanic and Atmospheric Administration (NOAA) P-3 airborne Doppler radar, the LANL portable Doppler radar, the University of Massachusetts high frequency mobile Doppler radar units were also used during this experiment (Bluestein, 1999). A new feature used during this experiment included roughly twelve mobile vehicles, each equipped with instruments to measure and record wind speed, wind direction, temperature, and humidity (Rasmussen et al. 1994). Another innovation introduced during this study was the use of global positioning system (GPS) satellites and receivers to document the location of all the data collected while allowing a coordinator to keep track of the locations of all the units in the field. Each member of the VORTEX project could be recorded at strategic locations in and near supercells.

The VORTEX project resulted in a fundamental change in the understanding of severe thunderstorm and tornado development. A result of the VORTEX project, field observations revealed striking kinematic similarities between tornadic and non-tornadic supercells. It is now known that both tornadic and non-tornadic supercell storms can contain strong low-level rotating updrafts, also referred to as mesocyclones (Bluestein *et. al*, 1998). Another result of the VORTEX project was the idea that the thermodynamic properties of downdrafts in mesocyclones can be an important factor in tornado formation and intensity. The understanding of thunderstorm features, such as outflow boundaries and anvil shadows were greatly enhanced during this project (Wurman *et. al*, 2012). Although researchers were not able to determine how exactly these features assisted in the evolution of tornadoes, data were collected to be simulated and studied. Additionally, the first detailed three-dimensional maps of the winds in a tornado were obtained by the prototype Doppler on Wheels (DOW) mobile radar (Bluestein, 1999). These three-dimensional images mapped the core and surrounding regions using fine temporal and spatial resolution by documenting the horizontal and vertical distribution of intense winds (Wurman *et. al*, 2012). These images gave scientists a first ever look at the evolution of tornadic winds, the central downdrafts, rapid changes in tornado structure, and the vertical and horizontal distribution of debris.

History: 2000s

After the successful completion of the VORTEX project in 1995, scientists were left with lingering questions about the evolution of supercell thunderstorms prior to and during tornadogenesis as well as during the life cycle of a tornado. Around the turn of the 21st century, scientists began planning a new research expedition to answer the lingering questions from the VORTEX project. This new research project, termed VORTEX2, would be the culmination of more than 100 scientists and students using 40 vehicles to document and study supercell thunderstorms and tornadoes (Cobb, 2010). Beginning in 2009, the overall goal of VORTEX2 was to improve the accuracy, lead time, and false-alarm rates of tornado warnings; observe the differences between non-tornadic supercells, weakly tornadic supercells, and violently tornadic supercells; and determine how thunderstorms interact with one another and with their local environment and how these interactions affect tornado genesis (Wurman *et. al*, 2012).

Using 10 mobile radars, including the DOW from the Center for Severe Weather Research (CSWR), SMART-Radars from the University of Oklahoma, the NO-XP radar from the NSSL, radars from the University of Massachusetts, the Office of Naval Research and Texas Tech University (TTU), 12 mobile instrumented vehicles (mesonets) from NSSL and CSWR, 38 deployable instruments (TTU), Tornado-Pods (CSWR), 4 disdrometers (University of Colorado (CU)), weather balloon launching vans (NSSL, NCAR and SUNY-Oswego), unmanned aircraft (CU), damage survey teams (CSWR, Lyndon State College, NCAR), and photogrammetry teams (Lyndon State Univesity, CSWR and NCAR), along with other instruments (Table 2.2.4), researchers were able to cover an area of approximately 1.2 million square kilometers from the Dakotas to southwestern Texas and from Colorado and Wyoming to Iowa and Missouri (VORTEX2, 2012).

Equipment:	Obtained From:	Significance:
Doppler on Wheels (DOW)	Center for Severe Weather Research (CSWR)	Mobile Doppler Radar
SMART-Radar	University of Oklahoma	5-CM Mobile Doppler radar
NO-XP Radar	National Severe Storms Laboratory (NSSL)	X-band dual-polarimetric mobile radar
Mobile Radar	Office of Naval Research & Texas Tech University (TTU)	Mobile Doppler radar
Mesonets	NSSL & CSWR	Instrumented vehicles
Sticknets	TTU	Deployable instruments
Tornado-Pods	CSWR	1 meter tall instrument tower
Disdrometers	University of Colorado (CU)	Instrument that measures the size and velocity of falling precipitation
Unmanned Aircraft	CU	Remote controlled aircraft
Damage Survey Teams	CSWR, Lyndon State College, National Center for Atmospheric Research (NCAR)	Team that survey damage after the incident
Photogrammetry Teams	Lyndon State College, CSWR, NCAR	Making precise measurements from photographs

Table 2.1 Table listing the instruments and their significant features used during the VORTEX2 project.

The first year of the project, 2009, was a challenging year for the VORTEX2 team. The result of an uncommonly quiet storm year, many objectives of the VORTEX2 project were not achieved. However, on 5 June 2009, VORTEX2 was able to observe the complete life cycle of a long-lived and strong tornado (Wurman *et. al*, 2012). Multiple radars, mobile documenters, pods, disdrometers, StickNet, and photogrammetry teams were deployed during the tornado's lifetime. At one time, at least six different radars were observing the storm.

2010 proved to a much more promising storm season compared to the previous year. During the final year of the VORTEX2 project, data was collected from over a dozen tornadic supercells (VORTEX2, 2012). Unfortunately, with the exception of 10 May 2010, most of these tornadoes were weak and short lived. At the time of this writing, data is still being analyzed and should be published in the coming years.

Severe Weather Documenters

As listed in the previous section, the United States has a rich history of observing and documenting severe weather. Indeed, many of the individuals who took part in some of the most exciting research expeditions are still in the field today, either as storm chasers or as storm spotters. The term "Storm Chaser" or "Storm Spotter" is given to an individual who documents severe weather. While both storm chasers and storm spotters observe and document severe weather, there are fundamental differences between the two. A storm chaser is defined as someone who observes and follows a developing thunderstorm either for educational purposes, scientific research, or as a recreational activity (Robertson, 1999). According to Jones and Coleman (2004) there are nine basic categories of people or groups who chase and intercept severe weather. These categories include scientists and researchers, hobbyists and amateurs, spotters, media personnel, tour groups, thrill seekers, locals, hurricane hunters, and fulltime professionals. A storm spotter on the other hand, is defined by the National Weather Service (2007) as a volunteer or paid county or municipal employee who is spotting as a community service. Today, there are thousands of these storm chasers and storm spotters throughout the United States.

Storm Chasers

As mentioned previously, storm chasing began as a scientific research endeavor in the 1970s. Today, storm chasing has developed into an activity not solely comprised of researchers. In fact, the majority of those who engage in storm chasing do so as a leisure activity (Bluestein 1999). Storm chasers who decide to enter the field to chase down severe weather must accept some level of responsibility for their own safety. When inexperienced individuals enter the field to chase severe weather they endanger other storm chasers along with members of the public. Unfortunately, as a result of movies, television shows, and printed stories, many have been misinformed about the activities of storm chasing. The false portrayals about the ease and constant fortune of storm chasing and intercepting severe weather has encouraged many inexperienced individuals to go out and chase storms for all the wrong reasons, sometimes resulting in deadly consequences (Jones and Coleman, 2004). It is this reason why the NWS does not partner with storm chasers, except for strictly research purposes.

Storm Spotters

The period from 1925 onward, saw a nationwide population movement away from rural areas and into cities (Doswell, Moller, and Brooks, 1999). This population movement resulted in a number of large, clustered cities spread throughout the country. This resulting population trend had, and continues to have, two counteracting implications for severe weather events. By clustering the population, the chances of a population center being hit by a severe weather event is greatly reduced. However, on the rare occasions when a highly populated area is affected by a severe weather event, the potential for casualties is greatly increased (Ashley, 2007). This example of population trend can be seen in one of the most famous severe weather outbreaks in U.S. history. On March 18, 1925 a long-tracking, deadly tornado tore through the states of Missouri, Illinois, and Indiana killing nearly 700 and injuring thousands (Akin, 2000). The aftermath of the Tri-State tornado initiated a trend toward public awareness and warning. Combined with new radio and telephone communications technology, the NWS began to prepare volunteers to report on potentially disastrous severe weather events that continue to this very day (Doswell, Moller, and Brooks, 1999). These NWS organized volunteers, i.e. storm spotters, are an integral part of the National Weather Service's plan to reduce causality rates during severe weather and tornado outbreaks.

The NWS is tasked with providing weather, water, climate data, forecasts, along with watches and warnings for the protection of life and property and enhancement of the national economy (NWS, 2012). The NWS also accepts the responsibility of training severe weather spotters who volunteer to serve their communities by watching for imminent severe weather events, forecasts, watches, and warnings to prepare people in the case of severe weather (Doswell, Moller, and Brooks, 1999). These NWS meteorologists depend on real-time storm reports from trained storm spotters to know exactly what is occurring on the ground during a storm. The NWS trains individuals to identify severe storms and tornadoes and report them via local and county emergency management, law enforcement, and amateur radio communications networks. While some spotters are mobile spotters in vehicles, the majority of spotters report from a fixed, strategic location around a community or county. The purpose of storm spotting is to alert community officials and the NWS and assist in warning the public.

Chaser and Spotter Training

There are several different methods available to become a storm chaser or storm spotter. One of the best recommendations, regardless of preference, is to become involved in the field of severe weather science. An introduction into the field will give interested weather enthusiasts a much needed background into formation, storm structure, hazards, lifecycle, etc. of severe storms. Many four-year university institutions, i.e. Metropolitan State University of Denver, offer storm chasing classes and field trips that are open to students and to the public. Additionally, becoming a member of SKYWARN and volunteering as a storm spotter will introduce enthusiasts to the applied side of severe weather science while teaching enthusiasts what to look out for in the field. As technology increases, so does the medium in which to reach people. One notable organization, out of the many available, offers weather enthusiasts an introductory background into severe weather science, all from the comforts of one's own home. Using the internet, members of SpotterNetwork can gain a brief understanding of severe weather without ever having to go outside.

SKYWARN

To obtain critical weather information, NOAA's NWS, part of the U.S. Department of Commerce, established the SKYWARN weather spotter program in the late 1960s. SKYWARN helps to keep local communities safe by reporting wind gusts, hail size, rainfall, cloud formations, etc. while effectively distributing information from the NWS using approximately 300,000 trained severe weather spotters (SKYWARN, 2012). Since the establishment of SKYWARN, the information provided by spotters, coupled with Doppler radar technology, improved satellite and other data, has enabled the NWS to issue more timely and accurate warnings for tornadoes, severe thunderstorms, and flash floods (Doswell, Moller, and Brooks, 1999).

Currently, SKYWARN operates in a fragmented manner operating either through local Weather Forecast Offices (WFO) or through unregulated local, state, or regional chapters which may or may not work directly with a local WFO (Jans and Keen, 2012). There are over 200 independent groups and chapters within the SKYWARN community. Members can choose to operate individually, having no association with either a local WFO or independent group or chapter (SKYWARN, 2012). The NWS offers free classes several times a year at the local WFO to anyone interested in becoming a SKYWARN storm spotter. Typically lasting approximately two hours, the spotter course covers topics such as the basics of thunderstorm development, fundamentals of storm structure, identification of potential severe weather features, reporting information, severe weather safety, etc (SKYWARN, 2012). Although classes are offered to anyone interested in severe weather science, it should be noted that SKYWARN does not require any kind of standardized registration or testing after the conclusion of the course (Jans and Keen, 2012).

SpotterNetwork

In 2006, AllisonHouse LLC introduced an organizational network to incorporate storm chasers, storm spotters, coordinators, and public servants in a seamless network of information (Pietrycha *et. al*, 2009). This organization (SpotterNetwork) was formed with the goal of providing accurate position data storm chasers and storm spotters for coordination and reporting by providing ground truth to public servants engaged in the protection of life and property (SpotterNetwork, 2012B). Designed to improve the flow of real-time information without taxing human resources, SpotterNetwork allows a storm observer to report on several types of severe weather hazards through a graphical user interface on a personal computer which can then be received by a meteorologist at the NWS within 45 seconds (Jans and Keen, 2012). This ability allows meteorologists to accurately quantify severe weather reports in real-time.

Beginning in 2009, in response to a growing concern over poor quality of storm reporting, standardized training became a requirement for all SpotterNetwork members. Using an online Moodle-based program using an open-source PHP web application, participants are exposed to a visual and practical understanding to storm spotting and reporting (Jans and Keen, 2012; SpotterNetwork, 2012B). Since implementation of the *Awareness Level Training Course*, there have been over 15,000 attempts and over 5,800 successful completions of the testing stage following the training course (Jans and Keen, 2012). With over 21,500 members, SpotterNetwork, is quickly becoming a household name in the field of severe weather and participating individuals.

Future Work

As the technology used to probe the still unknown questions about severe storms develops, so too will the understanding of those who study severe weather and the resulting hazards. Technology has grown by leaps and bounds over the past 100 years. The outdated, bulky, and hardly portable equipment used by the first researchers and observers has been replaced by mobile hand-held devices used by today's storm chasers and storm spotters. This advancement in technological understanding has resulted in a paradigm shift in the discipline, the likes of which were only dreamed about by past scholars. The next 100 years will be an interesting and exciting time to see what new inventions are created to answer some of the remaining unknown questions. Can technology assist the NWS in increasing the lead-time of severe thunderstorms, whereby decreasing the number of fatalities caused by thunderstorm hazards? Will scientists be able to determine what makes some supercell thunderstorm tornadic and some non-tornadic? What implications will climate change have on severe weather patterns and outbreaks? Only time will tell.

Summary

Severe weather impact thousands of people every year in the United States. Defined as a thunderstorm that produces either one inch diameter sized hail (or greater), wind gusts of 58 miles per hour (or greater), or a thunderstorm that produces a tornado, roughly 10% of the thunderstorms experienced in the US are termed severe (NSSL, 2012; SpotterNetwork, 2012A). Currently, there is new evidence that supports the theory of multiple tornado alleys across the United States. No longer defined as the singular Tornado Alley, these multiple tornado alleys occupy distinctive geographic regions throughout the country.

The idea that severe thunderstorms should be observed and monitored led to the first organized programs dedicated to the study of severe thunderstorms and tornadoes back in the late 1960s (Bluestein, 1999). The results of the observation programs in the 1970s led to the first established methodology for intercepting a severe thunderstorm. The research programs in the 1980s led to the discovery that parcel theory, along with the latent heat release from freezing super-cooled water drops, and upward-directed perturbation-pressure gradient were found to be the significant forces contributing to the tremendous updraft speed in supercell thunderstorms (Weisman and Klemp, 1984). It was also during this time that major strides were made in the areas of portable Doppler radar. The 1990s were noted for the multiplatform, storm intercept, field experiment termed Verification of the Origins of Rotation in Tornadoes Experiment (VORTEX) in the southern plains which helped shed light on tornadogenesis, tornado dynamics, and kinematics in severe thunderstorms and tornadoes (Rasmussen et al. 1994). Fourteen years later, in 2009, the second VORTEX research project began with the goal of answering lingering questions from the first project.

Today, there are thousands of storm chasers and storm spotters throughout the United States documenting the occurrence of severe weather. Defined as someone who observes and follows a developing thunderstorm either for educational purposes, scientific research, or as a recreational activity, storm chasers are typically not associated with the NWS (Robertson, 1999). A volunteer or paid county or municipal employee who spots severe weather, and its associated hazards, as a community service for the NWS is defined as a storm spotter (NWS, 2007).

With approximately 300,000 trained severe weather spotters, SKYWARN attempts to keep local communities safe by reporting wind gusts, hail size, rainfall, cloud formations, etc. while effectively distributing information from the NWS (SKYWARN, 2012). SpotterNetwork was formed with the goal of providing accurate ground truth member position data to allow meteorologists to accurately quantify severe weather reports in real-time (SpotterNetwork, 2012B). By incorporating standards with the innovative technologic capabilities, SpotterNetwork is quickly becoming a major powerhouse in the field of severe weather science.

As the technology develops, so too will the understanding of those who study severe weather and the resulting hazards. In the past 100 years technology has made amazing strides. The outdated equipment first used by researchers and observers has been replaced by mobile hand-held devices. This advancement in technological understanding has resulted in a paradigm shift in the discipline, the likes of which were only dreamed about by past scholars. The next 100 years will be an interesting and exciting time to see what new inventions are created to answer some of the remaining unknown questions.

3. METHODS

Survey Instrument

In Spring 2012, a survey instrument was created to document the responses of the participants used in this study. By using a survey questionnaire as the tool to test the hypothesis of this study, a plethora of information could be gathered with relative ease over a short period of time. Comprised of a mixture of 32 yes/no, multiple choice, and short answer questions (Appendix A), this survey questionnaire sought to analyze several key aspects of severe weather documenters. One aspect to be analyzed would be the participant's level of atmospheric science and or meteorology educational background, whether formal (attained from a four year university system) or informal (attained online or through a collective meeting setting). Another aspect to be analyzed was the severe weather documenter's background and history in documenting severe weather. Also analyzed would be any potential opportunities for gaining further education in the field of atmospheric science and or meteorology. The distance, both average and maximum, that a participant would typically travel throughout the severe weather season would also be examined through this survey questionnaire. Another aspect to be analyzed would be any monetary gains that may be made by documenting severe weather. Finally, any issues encountered when documenting severe weather would also be analyzed.

It was estimated that approximately 100 responses would be needed to accurately perform statistical testing for the hypothesis of this study. Because storm chasers and storm spotters are scattered throughout the United States, collecting enough responses would need to be accomplished in two ways: electronically and physically. Using the tools available through the organizational network, SpotterNetwork, the electronic participants used in this study were located. The "Active Members" graphical user interface through SpotterNetwork allows current members to monitor where severe weather is actively occurring while also monitoring reports of severe weather activity as they are reported by chasers and spotters throughout the United States (SpotterNetwork, 2013). Another unique characteristic about this graphical user interface allows all active members the option of being represented as a clickable icon when in the field. This icon can contain contact information viewable to other members. When using the graphical user interface, any member can click on an individual icon and access the information supplied by the storm chaser or storm spotter for which the icon is associated. This unique characteristic allowed for the collection of numerous email addresses which would prove to be paramount.

By using this interface to access the aforementioned information, a total of 504 email addresses were obtained from members who chose to openly distribute their contact information, specifically their email address information. Once these email addresses were obtained, a medium would be needed to collect and store the numerous survey responses. This medium would need to have the capability to store potentially large volumes of survey responses for a long duration. The tool chosen to collect and store these survey responses was the company "SurveyMonkey". SurveyMonkey is one of the leading providers of web-based survey solutions allowing users to gather information from a variety of people, organizations, as well as Fortune 100 companies (SurveyMonkey, 2013). This company would not only be able to generate and store the large number of survey responses, but would also be able to hyperlink the surveys via email resulting in less complication and faster response times.

Institutional Review Board

Because this study relies on the responses from human beings, Institutional Review Board (I.R.B.) approval was needed before responses could be collected and examined. Defined as a local administrative body with the goal of protecting the rights and welfare of human research subjects in research conducted under the sponsorship of Minnesota State University, Mankato, the I.R.B. has the authority to approve, require modification in, or disapprove any research activities within its jurisdiction (MNSU, 2013). The I.R.B. is tasked with providing any and all assurances to any research subject that every attempt has been made to protect his or her safety and rights as a research participant.

In April 2012, the research application for this study was submitted for I.R.B. approval. Submitted along with this application was the survey questionnaire to be answered by participants along with a survey consent form (Appendix B). The survey consent form would be the first piece of information that participants would examine before beginning the survey. In this consent form participants would be introduced to the background of this research study as well as the types of questions that would be asked on the survey. Included in this consent form was contact information for the principal and co-investigators in case any problems or concerns regarding any of the questions were encountered. By completing this survey, participants agreed to participate in this study and stated that they were at least 18 years of age and were aware that all of their responses would be held confidential for a period of up to three years. On April 30, 2012, the application for this research study, I.R.B. number 329240-3, was given I.R.B. approval.

Funding

Because the survey responses would prove paramount in either proving or disproving the hypothesis of this research study, a two-fold approach would be needed to accumulate enough data to accurately test the study's hypothesis. While 504 email addresses had been collected and processed electronically using the survey tool SurveyMonkey, the second approach to collecting responses would need to be accomplished in the field while severe weather was actively occurring.

To accomplish this goal, two funding applications were made to the Department of Geography at Minnesota State University, Mankato. The first application was for the George J. Miller scholarship. The George J. Miller scholarship is awarded to any student who majors in Geography, Earth Science, and/or Social Studies (Geography Concentration) with the goal of becoming a teacher or professor of Geography or Earth Science (MNSU, 2007). This scholarship award could be used for either tuition payment or field methods research and is valued between $500 and $1800, depending on the number of award recipients. The second funding source was the James F. Goff research endowment. The James F. Goff research endowment supports graduate students in the Department of Geography who are conducting thesis research. This research award can be used for any research related costs, along with up to 25% of the award being used for expenditures such as costs of living. A student who applies for this endowment can only receive it once and is valued between $2000 and $4000, depending on the number of award recipients (MNSU, 2007).

In April 2012, the two funding applications were accepted and both awards together totaled approximately $4,250.00. The amount awarded for the George J. Miller scholarship totaled $1,250.00 while the James F. Goff research endowment award totaled $3,000.00. With these funding sources, storm chasers and storm spotters could be located and asked to participate in this study while in the field documenting severe weather events.

"Chasing the Chasers"

On May 31, 2012, a mass email containing the hyperlink to the electronic survey was distributed to the 504 potential participants of this study. Over the next several weeks, while the electronic survey gathered responses, the distribution of physical survey responses was conducted. Spanning 14 states (Minnesota, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Missouri, Oklahoma, Texas, Colorado, Utah, Nevada, and Arizona), additional participants were located during several severe weather outbreaks, as seen in Figures 3.1, 3.2, 3.3, 3.4, and 3.5. A total of five copies of the physical survey were given out to random storm chasers and storm spotters. One common result experienced when approaching storm chasers and storm spotters was that many had already received the electronic email request and many had already completed the survey. On June 21, 2012, after three weeks of distributing the physical copy of the survey to severe weather documenters, the distribution of physical surveys was concluded. Unfortunately, none of the five distributed physical survey copies were returned for processing.

On July 28, 2012, approximately two months after beginning the process of data collection, the collecting of survey responses came to a close. Over the two month window available for storm chasers and storm spotters to respond, approximately 219 individuals chose to participate in this study, more than twice the targeted goal. As seen in Table 3.1, the majority of responses occurred within the first five days after the survey was electronically distributed.

Date	Surveys Completed	Total Surveys Completed
May 30, 2012	0	0
May 31, 2012	73	73
June 1, 2012	103	176
June 2, 2012	11	187
June 3, 2012	8	195
June 4, 2012	4	199
June 5, 2012	2	201
June 6, 2012	6	207
June 7, 2012	2	209
June 8, 2012	1	210
June 9, 2012	0	210
June 10, 2012	1	211
June 11, 2012	2	213
June 12, 2012-July 28, 2012	6	219

Table 3.1 Summary of the number of surveys completed and the date which they were completed .

Figure 3.1 A developing supercell thunderstorm near Dallas, Texas on 4 June, 2012. © Paul Zunkel

Figure 3.2 A tornadic high precipitation (HP) supercell near Cheyenne, Wyoming on 6 June, 2012. © Paul Zunkel

Figure 3.3 A low precipitation (LP) supercell in Northeastern Colorado on 6 June, 2012. © Paul Zunkel

Figure 3.4 A rotating wall cloud near Atwood, Colorado on 7 June, 2012. © Paul Zunkel

Figure 3.5 A developing supercell thunderstorm near Denver, Colorado on 7 June, 2012. © Paul Zunkel

Data Analysis

In Spring 2013, the collected responses were taken back to Minnesota State University, Mankato to be analyzed and processed. Because the survey had been formatted to use a Likert scale, statistical analysis could be examined for both the yes/no and multiple choice questions. Defined as a type of psychometric scale frequently used in questionnaires, a Likert Scale would allow for easy statistical analysis. Developed and named after organizational psychologist Rensis Likert, responses can be ordered from one extreme (ex. 'strongly agree') to another (ex. 'strongly disagree') (Likert, 1932). In a Likert Scale it is common to code responses to questions as whole numbers (Gardner and Martin, 2007).

Statistical Package for the Social Sciences

To properly analyze the responses collected over the two month span, the software package "Statistical Package for the Social Sciences" (SPSS) was needed to generate the results in an accurate and timely manner. Acquired by International Business Machines (I.B.M.) in 2009, SPSS is defined as a data management and analysis product (IBM, 2013). SPSS offers many unique statistical features, including modules for statistical data analysis, including descriptive statistics such as plots, frequencies, charts, lists, as well as sophisticated inferential and multivariate statistical procedures like analysis of variance (ANOVA), factor analysis, cluster analysis, and categorical data analysis (UT, 2013). Because of the features offered with this product, SPSS is particularly well-suited to analyze survey research.

Chi-Squared Analysis

Data analysis for the yes/no responses of the survey questions were analyzed using Chi-Squared statistical analysis. The chi-squared test is used to evaluate the relationship between two nominal or ordinal variables (Voelker and Orton, 1993). As seen in Figure 3.6, the goal of this test is to examine if the distribution observed is significantly different compared to what might be expected (Kranzler and Moursund, 1999).

$$\chi^2 = \Sigma \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

Figure 3.6 The equation for Chi-Squared analysis. In this equation, Chi-squared analysis is represented by the symbol χ^2. Σ is defined as summation, or 'sum of'. 'Observed' relates the observed values and 'Expected' relates to the expected values.

When examining statistical data it is important to examine if the data are normalized and has a normal distribution. Defined as data that come from a population that has a normal distribution, normalized data is the most important and the most frequently used distribution in both the theory and application of statistics (NIST, 2012). When data are considered normal the shape of a resulting histogram will appear bell-shaped. Chi-squared analysis is one example of a non-parametric test, meaning the test does not require that its data be normalized. These non-parametric tests are typically used when assumptions about normal distribution in the population cannot be met when the level of measurement is ordinal or less (Voelker and Orton, 1993).

For this study, chi-squared analysis was used to examine if any of the variables (questions asked on the survey) were relatable to a severe weather documenter having a four year degree in atmospheric science and or meteorology. The null hypothesis for this thesis is that storm chasers and storm spotters who hold a four year university degree are no more likely to travel greater distances to document severe weather events, than those who do not hold a four year degree.

To analyze the survey questions in SPSS, eight of the twelve necessary yes/no questions were separated into eight individual Microsoft Excel tables. These eight questions were constructed to not only examine the background information of storm chasers and storm spotters but to also examine any possible impacts experienced when documenting severe weather. The eight tables were constructed with the first column containing all the generated responses for the independent question 'Have you previously graduated from a university system?' with one of the eight possibly dependent questions listed in the adjacent column. After constructing the eight separate Microsoft Excel tables, a slight modification was needed to allow for proper analysis in SPSS. Participants were given the option of not having to answer every question if they did not want to do so. In every constructed Excel table there were multiple gaps of missing information where participants either skipped or chose not to answer a certain question. To adjust for this problem, any row that contained a missing value for the independent and or possible dependent variable was deleted. This omission resulted in the overall number of responses for each question being less than the 219. Because 219 total responses had been collected, removing several rows of data would not compromise the results.

Analysis of Variance

As chi-squared analysis tested the yes/no questions against the null hypothesis, more statistical testing would be needed to analyze the selected multiple-choice questions. The statistical test chosen to analyze these specific responses was ANOVA (also known as Analysis of Variance). ANOVA analysis is one of the most popular parametric statistical analysis methods for analyzing group mean differences. In fact, beginning in the 1920s, the statistical analysis ANOVA has been one of the standard methods for examining mean differences in experimental designs (Li, and Lomax, 2011). As seen in Figures 3.7 and 3.8, the overall goal of using ANOVA analysis is to test for statistical significance of the differences among the means of multiple groups.

$$SS_{tot} = \Sigma X_{tot^2} - \frac{(\Sigma X_{tot})^2}{N}$$

Figure 3.7 The formula for the total variability in ANOVA also termed the sum of squares, abbreviated SS (Wilson, 2005). In this equation, ΣX_{tot^2} is defined as the summation of all the squared x-values while $(\Sigma X_{tot})^2$ is defined as the summation of all the x-values which are then squared. N is defined as the number of scores.

$$SS_{BG} = \Sigma\left(\frac{(\text{Column Total})^2}{n}\right) - \frac{(\Sigma\, X_{tot})^2}{N}$$

Figure 3.8 The formula for the one-way, between-groups variability, termed SS_{BG}, which was used for the ANOVA data analysis for this study (Wilson, 2005).

ANOVA examines the amount of variability (i.e. difference) between the means of the groups compared to the amount of variability among the individual scores in each group (Kranzler and Moursund, 1999). This technique allows users to compare the variability among the group means with the variability that occurred by chance or by error. Simply put, ANOVA analysis tests the variance between groups versus the variance within groups. This analysis would prove beneficial in comparing the statistical relationship between a severe weather documenter's confidence level in his or her background knowledge in atmospheric science versus their educational background.

Correlation Analysis

During the creation of the survey questionnaire, several unique questions were created to specifically test for a correlation between a severe weather documenter's confidence in their background atmospheric science knowledge, as well as their education level, and their range of travel during severe weather events. Defined as a possible relation between multiple variables, this correlation would shed light on how education and confidence level influences the traveling distance of storm chasers and storm spotters (Triola, 2008). When a study wants to examine two specific variables a

Bivariate correlation analysis is often used. Bivariate correlation aims to evaluate the degree of relationship between two quantitative variables or attributes (Voelker and Orton, 1993). This analysis explores the relationship between two variables and examines whether there exists an association and possible strength of this association, or whether there are differences between two variables and the significance of these differences.

Because two of the examined variables were found to have distributions which did not meet the assumptions of the parametric, i.e. they did not have normal distributions, a non-parametric test was needed to examine these variables. The non-parametric statistical test chosen to analyze these variables was Spearman's Rank Correlation Coefficient. This test is a measure of the strength of the associations between two indicated variables (Weisstein, 2013). Because the Spearman's test is a statistical ranking, values that are identical or are duplicates are assigned a rank equal to the average of their positions in the ascending order of the values. Much like its parametric counterpart, Pearson's *r*, the coefficient for the Spearman's test varies between -1.0 to 1.0 (Voelker and Orton, 1993).

$$r_s = \left[1 - \frac{6\Sigma D^2}{N^3 - N}\right]$$

Figure 3.9 The formula for the Spearman's Rank Correlation Coefficient. In this equation, the Spearman's rank coefficient is represented by r_s and relates to the correlation of a sample. The summation of the indicated items is represented by the symbol Σ and D is represented as the rank of the x-values subtracted from the rank of the y-values. (Plonsky, 2012).

4. RESULTS

Chi-Squared Analysis

As previously mentioned, chi-squared analysis is used to examine if an observed distribution is significantly different compared to the expected distribution (Kranzler and Moursund, 1999). In SPSS, the higher the chi-squared value, the more relatable the two variables are to one another. After attaining a chi-squared value, a significance value is needed to check for legitimacy in the resulting chi-squared value. To check for this legitimacy, the significance value, or p-value, would be examined. Defined as the probability that the resulting chi-squared value was obtained by chance, the p-value is used check the statistical significance of the chi-squared value. To reinforce the chi-squared result, the p-value must be less than 0.05 to be considered significant (Wilson, 2005).

Because this study sought to examine if a four year degree from a university system has any impact on a severe weather documenter's geographic dispersion during severe weather events, the survey question *Have you previously graduated from a university system?* was deemed the independent variable for which all other questions were to be compared. This question was to be compared to the other yes/no questions to examine if these other variables are dependent or relatable to the independent variable.

Graduated University

The first question examined the independent question alongside the question *Do you have any spotting and or chasing education?*. By examining these two questions a correlation could be determined by showing if a four year university degree has any effect on having storm chasing or storm spotting education. After modifying the table to omit any missing responses, a total of 210 responses were analyzed. The results of the analysis showed a low chi-squared value of 1.237 with a p-value of .539, greater than the 0.05 threshold for significance. As seen in Appendix C, Figure 1, this analysis quickly showed that the two questions were not related and were independent of one another.

The second question to be analyzed against the independent variable examined if having a four year university degree had any effect on group member association. The question *When spotting and or chasing, are you alone? Or part of a group?* was compared against the independent variable. With a total number of responses of 209, the SPSS analysis resulted in a very low chi-squared value of .041 with a p-value of .839. As seen in Appendix C, Figure 2, these two questions are not related and are independent from one another.

The third chi-squared test was a continuation from the second test and examined group member educational background. This third test examined the independent variable against the question *Do other members of your group have any background in atmospheric science and or meteorology?*. By examining these two questions a possible correlation could be made to show that storm chasers and or storm spotters associate with others who also have a similar academic background when documenting severe weather. The number of responses for this question totaled 121 and showed a strong correlation to the independent variable. As seen in Figure 4.1 (Appendix C, Figure 3), the chi-squared value totaled 5.586 with a p-value less than the 0.05 threshold of .018. The analysis of this question showed that this variable *Do other members of your group have any* *background in atmospheric science and or meteorology* is related to having a four year university degree.

The fourth analysis examined the independent variable *Have you previously graduated from a university system* against the question *If given the opportunity, would you spot and or chase more than you do currently?*. This analysis would examine if having a four year university degree has any correlation to the number of times a storm chaser or storm spotter documents severe weather throughout the year as well as any desire to increase the number of documenting instances. The number of responses for this analysis was 205 and the analysis showed a high chi-squared value of 8.333, meaning there was statistical significance. The p-value for this question was totaled .004. After further examination, although the chi-squared value was large it was determined that these two questions were in fact not related to one another (Appendix C, Figure 4).

The fifth Microsoft Excel table analyzed the independent variable against the possibly dependent variable *Are there currently any obstacles preventing you from traveling to go storm spotting and or storm chasing?*. This comparison would answer the question of preventative obstacles and university education. This test would examine if individuals who held a four year university degree experienced more or less obstacles when traveling to document severe weather compared to those who did not have a college degree. Of the 205 SPSS compared responses, the chi-squared analysis showed a value of 2.043 with a p-value of .153. Although the chi-squared value was higher, the high p-value resulted in the two questions being independent of one another (Appendix C, Figure 5).

The sixth test examined the interdependence between the independent and the responses from the question *Have you received monetary gain through storm spotting* *and or storm chasing?*. By examining these two questions, an analysis could be made between individuals who had taken some sort of college education and those who were profitable and made money by documenting severe weather. As seen in Appendix C, Figure 6, of the 205 responses used for this analysis, the reported chi-squared value was a large value of 5.526 with a significance level (p-value) of .019. Similarly to the fourth test, it was determined that the two questions were in fact not related to one another despite the high chi-squared value.

Continuing in regards to the previous test, the seventh Microsoft Excel table examined the independent question and the possibly dependent variable *Are you able to make enough money to cover your expenditures for the season?*. This analysis was aimed at examining if individuals with a four year college degree were able to make enough money to continue documenting severe weather compared to those whom have not had any college education. Unlike the previous analysis, the seventh test had a lower number of responses, a total of only 57, as seen in Appendix C, Figure 7. However, even though there was a low response rate, the results were quite clear. The chi-squared analysis for the seventh test was .147, with an associated p-value of .702, resulting in the two questions being independent and not relatable to one another.

The eighth analysis examined the independent variable against the question *If you had more education in storm spotting and or storm chasing would you be more comfortable chasing severe storms over a greater distance?*. By examining these two questions, a possible correlation could be made to link an individual's education level with the distance traveled for severe weather documentation. The results generated by the SPSS software proved surprising. Using the 205 responses generated between the two questions, the chi-squared analysis resulted in a value of 13.473. With a p-value of .000, the results of this analysis showed that storm chasers and storm spotters who did not have a four year degree from a university would be much more comfortable documenting severe weather over a greater distance if more education was gained. As seen in Figure 4.2 (Appendix C, Figure 8), the two questions are very much related and reinforce the idea that more education would allow for greater distance traveled.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Have you previously graduated from a University System?	121	100.0%	0	0.0%	121	100.0%

Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology?	No	Count	36	29	65
		% within Have you previously graduated from a University System?	65.5%	43.9%	53.7%
	Yes	Count	19	37	56
		% within Have you previously graduated from a University System?	34.5%	56.1%	46.3%
Total		Count	55	66	121
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.586[a]	1	.018		
Continuity Correction[b]	4.754	1	.029		
Likelihood Ratio	5.644	1	.018		
Fisher's Exact Test				.028	.014
N of Valid Cases	121				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 25.45.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.215	.018
	Cramer's V	.215	.018
N of Valid Cases		121	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 4.1 The SPSS results of the third chi-squared analysis test. In this test the chi-squared value (5.586) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.018) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance? * Have you previously graduated from a University System?	205	100.0%	0	0.0%	205	100.0%

If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		
			No	Yes	Total
If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance?	No	Count	38	78	116
		% within Have you previously graduated from a University System?	42.2%	67.8%	56.6%
	Yes	Count	52	37	89
		% within Have you previously graduated from a University System?	57.8%	32.2%	43.4%
Total		Count	90	115	205
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13.473[a]	1	.000		
Continuity Correction[b]	12.451	1	.000		
Likelihood Ratio	13.564	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	205				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 39.07.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.256	.000
	Cramer's V	.256	.000
N of Valid Cases		205	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 4.2 The SPSS results of the eighth chi-squared analysis test. In this test the chi-squared value (13.473) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.000) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Some University Experience

After the chi-squared analysis of the question *Have you previously graduated from a university system?*, a second round of testing began on another independent question to see if there exists a correlation between university education and factors influencing geographic dispersion during severe weather events. The new independent variable *Have you taken some college courses but do not have a degree from a four year university institution?* was examined against the same variables tested for the first independent question. Using the data collected over the two month span, the responses of participants who have taken college classes yet have not achieved a four year degree were tallied. Approximately 99 responses were generated by participants whether they had or had not received some university education.

The first analysis of the new chi-squared test for some college taken at a university compared the independent variable *Have you taken some college courses but do not have a degree from a four year university institution?* against the question *Do you have any spotting and or chasing education?*. As with the first analysis, this new analysis was aimed at examining if having any college education would have any effect on having storm chasing or storm spotting education. The results for this test (Appendix C, Figure 9) revealed a chi-square value of 2.252 with a p-value of .324. Although the test gave a relatively significant chi-squared value, the p-value was above the 0.05 threshold resulting in the two variables being unrelated and independent from one another.

The second test for the new independent variable compared the independent question to the possibly dependent variable *When spotting and or chasing, are you alone? Or part of a group?*. Much like the second chi-squared analysis using the first independent variable, this test would examine if having any university experience had any effect on group member association. Using the 94 responses generated for this analysis, the chi-squared results showed a value of 3.040 and with a p-value of .081 (Appendix C, Figure 10). Although deemed not dependent, this analysis revealed an interesting detail about both variables. Individuals who responded that they do not have any university experience related quite highly to those who spot and or chase severe weather alone.

The third chi-squared analysis test for the new independent variable sought to examine the independent variable against the question *Do other members of your group have any background in the fields of atmospheric science and or meteorology?*. The examination of these two questions would reveal a possible correlation between storm chasers and storm spotters and their associates. As seen in Figure 4.3 (Appendix C, Figure 11), by examining the 55 total responses for both questions, the resulting chi-squared value was 4.516 with an associated p-value of .034. Like the third test for the original independent variable, this test also had a high chi-squared value resulting in the two questions being dependent and very much related to one another. Because this test was statistically proven to show a correlation between the two variables, the assumption that those with some college education choose to associate with others who have a background in atmospheric science and or meteorology.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Do you have some University experience?	55	100.0%	0	0.0%	55	100.0%

Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		
			No	Yes	Total
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology?	No	Count	16	20	36
		% within Do you have some University experience?	84.2%	55.6%	65.5%
	Yes	Count	3	16	19
		% within Do you have some University experience?	15.8%	44.4%	34.5%
Total		Count	19	36	55
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.516[a]	1	.034		
Continuity Correction[b]	3.338	1	.068		
Likelihood Ratio	4.869	1	.027		
Fisher's Exact Test				.041	.031
N of Valid Cases	55				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.56.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.287	.034
	Cramer's V	.287	.034
N of Valid Cases		55	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 4.3 The SPSS results of the eleventh chi-squared analysis test. In this test the chi-squared value (4.516) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.034) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

The fourth analysis, Appendix C, Figure 12, examined the independent variable against the question *If given the opportunity, would you spot and or chase more than you do currently?*. This analysis would examine if having any college education has a correlation to the number of opportunities a documenter spots and or chasers severe weather throughout the year. The result of chi-squared results analysis showed a value of .026 with a p-value of .872. This analysis showed that the two variables examined in this test were extremely independent and nowhere close to relating to each other.

The fifth test used chi-squared analysis to examine the independent variable against the question *Are there currently any obstacles preventing you from traveling to go storm spotting and or storm chasing?*. This test would examine if individuals who have taken some college courses have experienced more or less obstacles when traveling to document severe weather compared to those who have not taken any college courses. As seen in Appendix C, Figure 13, the results of this test gave a chi-squared value of 1.330 with a significance level (p-value) of 2.49. This analysis proved independence and little or no relation.

Using the new independent variable *Have you taken some college courses but do not have a degree from a four year university institution?*, the sixth chi-squared analysis examined the independent variable against the dependent variable *Have you ever received monetary gain through storm spotting and or storm chasing?*. By comparing the two, information could be gained on whether those who have some college education financially gained from documenting severe weather compared to those who have not taken any college courses. Using the combined 90 responses, the chi-squared analysis resulted in a value of .182 with a p-value of .670 resulting in the two variables being independent of one another (Appendix C, Figure 14).

The seventh analysis compared the independent question *Have you taken some college courses but do not have a degree from a four year university institution?* to the variable *Are you able to make enough money to cover your expenditures for the season?*. The purpose of this analysis would be to examine if those individuals who have some college experience are able to make enough money to cover their operating costs during the severe weather season compared to those who do not have any college experience. Due to the specificity of the possibly dependent question, this analysis (Appendix C, Figure 15) had a low response rate of only 17. The results of the chi-squared analysis gave a value of .069 with a p-value of approximately .793 resulting in the two variables being independent.

The final chi-squared analysis test using the second independent variable compared the independent variable to the eighth question *If you had more education in storm spotting and or storm chasing would you be more comfortable chasing severe storms over a greater distance?*. This analysis would test for a correlation linking an individual's education level with the distance traveled for severe weather documentation. Using the 89 responses generated between the two questions, the chi-squared analysis resulted in a value of .147 (Appendix C, Figure 16). With a p-value greater than the 0.05 threshold (.702), the results of this analysis showed that there was no correlation between documenters who had taken some college courses and more education to comfortably travel greater distances to document severe weather.

Analysis of Variance

In keeping with the hypothesis of this study, ANOVA analysis was used to examine the correlation between two unique variables. The first variable *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* was analyzed against the second variable *With what degree did you graduate?* to examine if confidence level in atmospheric science knowledge was related to a severe weather documenter's education level. As seen in Appendix D, Figure 1, by using One-Way, Between Groups, ANOVA analysis, the results of the test could be computed. After modifying the table to exclude any omitted data, the number of collected responses totaled 117.

The results from the One-Way, Between Groups, ANOVA analysis showed that when examining the relationship between a severe weather documenter's educational background and their confidence level in the field of atmospheric science, no correlation exists and the two variables are not related.

Correlation Analysis

The final portion of data analysis sought to analyze if there is a statistical correlation between a severe weather documenter's confidence level in their background knowledge of atmospheric science, along with their education history, with the distance they would typically travel to document severe weather. By testing these two variables, a possible correlation could be discovered which might explain why some storm chasers and storm spotters travel greater distances compared to others. Because two of the four variables *What is the average distance you travel to spot and or chase in a single day?*

and *What is the greatest distance you would travel in a single day to spot and or chase severe weather?* were found to have distributions which did not meet the assumptions of the parametric, i.e. they did not have normal distributions, the non-parametric test Spearman's Rank Correlation Coefficient was used to analyze for correlation and significance.

The first test analyzed the variable *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* against the variable *What is the average distance you travel to spot and or chase in a single day?*. The purpose of this test was to analyze if confidence influenced the average range of travel for a severe weather documenter. Using SPSS, the total number of responses totaled 208. As seen in Figure 4.4 (Appendix E, Figure 1), the Spearman's correlation analysis resulted in a coefficient of .346. This resulting coefficient was shown to be significant, yet only slightly, meaning that confidence level does influence the average range severe weather documenters travel for severe weather occurrences.

The second Spearman's analysis analyzed the variable *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* against the variable *What is the greatest distance you would travel in a single day to spot and or chase severe weather?*. By analyzing these two variables, a possible correlation could be examined to show if confidence level in atmospheric science background knowledge influenced the maximum range of travel for a severe weather documenter. Using the 208 combined responses, the spearman's correlation coefficient resulted in a value of .333 (Figure 4.5 (Appendix E, Figure 2)). Like the previous test, this analysis proved to be slightly significant. However, this test showed that there does exist a correlation between the confidence level of a severe weather documenter and the maximum distance they would travel to document severe weather.

Nonparametric Correlations

[DataSet1]

Correlations

			How confident are you in your background knowledge of Atmospheric Science/Meteorology?	What is the average distance you travel to spot/chase severe weather in a single day?
Spearman's rho	How confident are you in your background knowledge of Atmospheric Science/Meteorology?	Correlation Coefficient	1.000	.346**
		Sig. (2-tailed)	.	.000
		N	208	208
	What is the average distance you travel to spot/chase severe weather in a single day?	Correlation Coefficient	.346**	1.000
		Sig. (2-tailed)	.000	.
		N	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 4.4 The result of the Spearman's Rank Correlation Coefficient between the two variables *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* and *What is the average distance you travel to spot and or chase in a single day?*.

Nonparametric Correlations

[DataSet2]

Correlations

			How confident are you in your background knowledge of Atmospheric Science/Meteorology?	What is the greatest distance you would travel in a single day to spot/chase severe weather?
Spearman's rho	How confident are you in your background knowledge of Atmospheric Science/Meteorology?	Correlation Coefficient	1.000	.333**
		Sig. (2-tailed)	.	.000
		N	208	208
	What is the greatest distance you would travel in a single day to spot/chase severe weather?	Correlation Coefficient	.333**	1.000
		Sig. (2-tailed)	.000	.
		N	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 4.5 The result of the Spearman's Rank Correlation Coefficient between the two variables *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* and *What is the greatest distance you would travel in a single day to spot and or chase severe weather?*.

As the first two tests examined the relationship between confidence level and the range of distance traveled, the third analysis examined how a severe weather documenter's education level influenced their average range of distance. The third analysis examined if a correlation exists between the variable *With what degree did you graduate?* and the variable *What is the average distance you travel to spot and or chase in a single day?*. As seen in Appendix E, Figure 3, the 117 total responses were analyzed for a potential correlation. The results of this test showed a correlation coefficient of .048, resulting in the two variables not being related.

The fourth and final analysis paired the variable *With what degree did you graduate?* against the variable *What is the greatest distance you would travel in a single day to spot and or chase severe weather?*. The goal of this fourth analysis was to examine if education level influences the maximum distance a documenter would travel for severe weather. After analyzing the 117 generated responses (Appendix E, Figure 4), the results of this test showed little to no correlation as the correlation coefficient totaled .059. As a result of this low correlation coefficient, the two variables of this test were deemed not significant.

Descriptive Analysis

When the survey questionnaire was created, several questions were made which allowed for participants to select multiple answers. In particular, one question would be used to analyze where the majority of the respondents gained their education. This question *Where did you receive your storm spotting and or storm chasing education?* would be used to analyze if the majority of respondents gained their education from a university institution, from an organization, or from somewhere else. Because this question allowed participants to select multiple answers (Figure 4.6), the number of responses for this question resulted in a number higher than the 219 completed survey questionnaires. When examining the number of responses generated for the answer choice *A four year university institution*, a total of 33 participants selected this answer choice as the place where they received their storm spotting and or storm chasing education. A total of 140 participants selected the answer choice *SpotterNetwork* as where they received their storm spotting and or storm chasing education. Approximately 182 respondents chose the answer choice *SKYWARN* as the place where they received their education in atmospheric science and or meteorology. The fourth possible answer choice *No education taken* had a very low response total of only 3 respondents. The final answer choice *Other*, which comprised of answers varying from learning on their own time to the Canadian version of SKYWARN (CANWARN), totaled 61 responses for where respondents gained their atmospheric science and or meteorological background.

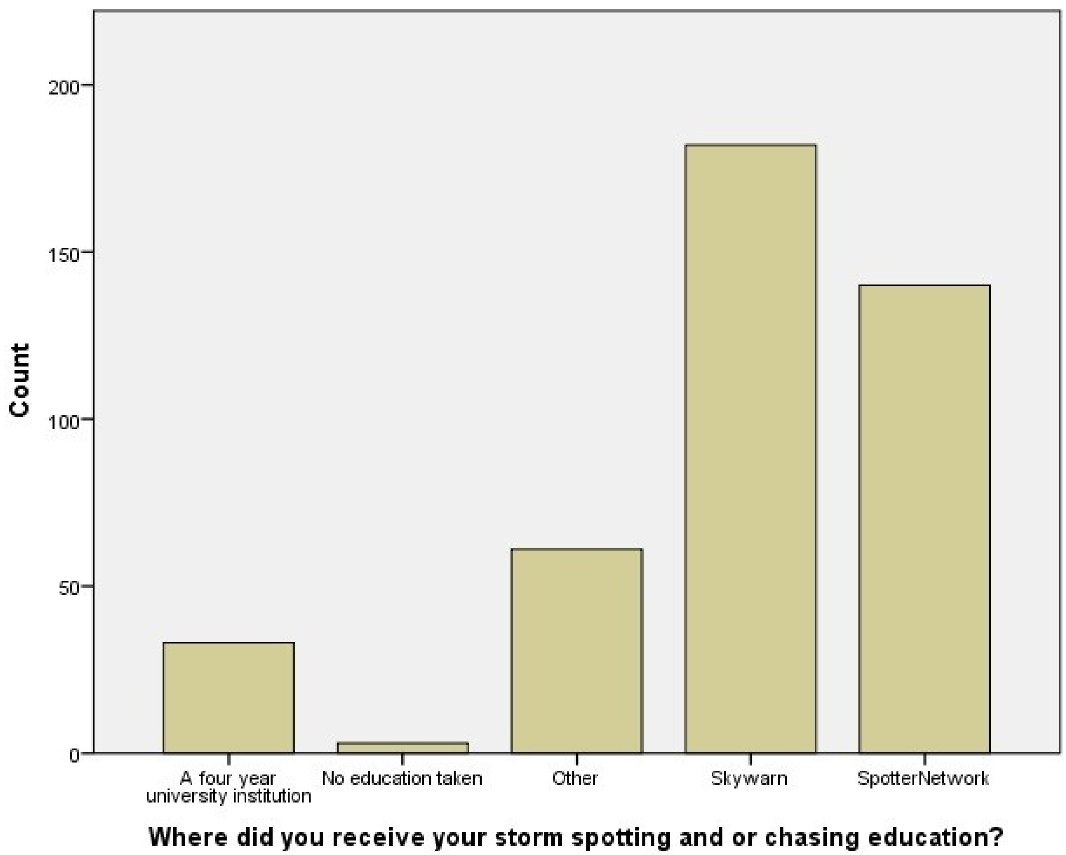

Figure 4.6 The descriptive analysis results of the multiple choice question 'Where did you receive your storm spotting and or storm chasing education?'.

5. DISCUSSION

Electronic Dissemination

During the distribution and dissemination of the electronic survey a formatting error resulted in a potentially significant effect on the total number of completed survey questionnaires. Due to author error, the formatting of the mass email message containing the email addresses of the 504 potential participant's was sent as a standard email message. As a result of this formatting all the email addresses of every participant asked to take part in this study were visible to everyone who received the email invitation. Although every email address was obtained openly by documenters who chose to distribute their information via SpotterNetwork, in hindsight, a BCC email format should have been used. A BCC (blind carbon copy) is defined as a formatting technique where a copy of an email message is sent to multiple recipients whose email addresses do not appear in the message (Tschabitscher, 2013).

As a result of this error, several potential participants replied rather nastily that they wished to be removed from this "spam" list and would not participate in this study. As stated in Hunter (2012), occasionally when distributing online survey questionnaires respondents can sometimes consider unsolicited surveys as intrusive or offensive. It appears that in this case that situation did unfortunately occur and it is unclear as to how many potential participants were lost due to this error. If any other survey based studies are conducted in the future, the mistake of improper email formatting will not be repeated.

Survey Questionnaire Formatting

The survey questionnaire used in this study was comprised of a combination of 32 yes/no, multiple choice, and short answer questions. The goal of this survey questionnaire was to analyze the numerous aspects and characteristics of a severe weather documenter. Because of the large number of questions asked on this questionnaire, a new variable was discovered which was not originally discussed during the creation of the survey instrument. This new variable was discovered when performing chi-squared analysis and resulted in a second round of testing being performed on this new variable. This new variable came from the question: if having completed some university courses, but not attaining a four year university degree, has any influence on the other eight variables chosen for this analysis (as seen in Appendix C, Figures 9-16).

The results of this second set of tests proved to be pleasantly surprising. One result of testing this new variable showed that individuals who do not have any university experience related quite highly to those who spot and or chase severe weather alone. Another result of this new variable exhibited a correlation that individuals with some college education choose to associate with others who have a similar background in atmospheric science and or meteorology. These two results explained that when documenting severe weather with a group of people, individuals with a background knowledge of atmospheric science and or meteorology don't want to associate with others who are not as knowledgeable. Due to the possible danger associated with documenting severe weather, this conclusion makes sense as people do not want to have to rely on someone who is less prepared and less knowledgeable, especially when things can turn dangerous very quickly.

Group Members

The data analysis portion of this research study showed several unique and interesting results. When examining the interdependence between having a four year university degree and whether any group members of a severe weather documenter are knowledgeable in the fields of atmospheric science and or meteorology a statistically significant correlation was found. This correlation shows that storm chasers and storm spotters who hold a degree from a four year university institution typically associate with others who have a similar background. The idea of a correlation between education and group member background knowledge reiterates a previously mentioned result but for a different independent variable. When a group of people enter the field to document severe weather all group members should possess a fairly consistent knowledge of the storms they are pursuing. If a group member or group members have no idea what they are doing or getting themselves into, their lack of experience or background knowledge can have disastrous and potentially fatal consequences.

Data Preparation

One discovery with this study was the amount of missing data present when all the responses had been assembled. Participants had the option of choosing not to answer every question if they do not want to do so and these missing responses resulted in missing data for multiple questions. This missing data created an inconvenience when attempting to perform data analysis for the chi-squared, ANOVA, and correlation analysis tests. Although approximately 219 surveys were completed and returned for analysis, the missing values from the unanswered questions falsely represented the amount of true data that could be used.

Due to the formatting structure needed to use the statistical analysis program SPSS, every Microsoft Excel table that was constructed needed to have two columns filled with rows of real data. Performing data analysis while using missing data can produce false results. To compensate for this issue, any missing values for either row of the two columns had to be omitted to perform data analysis. This omission resulted in the overall number of responses for each question being less than the total number of completed responses (219). By deleting rows containing missing values, useable data was omitted and could not used. In some cases as many as forty values were deleted to properly format the table for SPSS analysis.

To bypass this issue in the future, a monetary reward system may be introduced to encourage participants to complete every question of the survey questionnaire. Monetary incentives can encourage participants to complete more parts of a survey compared to if no incentives are offered (Hunter, 2012). If this study was to be repeated with offering possible incentives to participants, the likelihood of accumulating more data would increase resulting in a larger number of responses and possibly different results.

Educational Training

Because the hypothesis of this study focuses on the educational training of storm chasers and storm spotters, it is important to examine where the majority of the respondents gained their education for atmospheric science and or meteorology. One specific question on the survey questionnaire asked participants about where they received their education and allowed the participants to select several answers if it applied to them. The majority of the participants in this study responded by answering that they gained their education from the organizations SKYWARN and SpotterNetwork and not from a four year university institution. In fact, out of the 219 returned survey questionnaires, the answer choices SKYWARN and SpotterNetwork were chosen for a combined total of 322 responses compared to the only 33 responses for a four year university institution. While the response rate for a four year institution was lower than expected, in today's economic uncertainty, the results are not that surprising. The difference between these two options (SKYWARN and SpotterNetwork versus a four year university institution) and the reason why one is more preferred over the other simply comes down to money.

Attending college at a four year university institution is very expensive and requires a lot of time and effort. Though the training is much more challenging and interactive as students are required to take prerequisite classes (i.e. math, physics, chemistry, etc.), the amount of material covered vastly exceeds what someone would expect to cover through SKYWARN or SpotterNetwork. Because SKYWARN and SpotterNetwork both offer courses which are relatively inexpensive and short in duration, they are capable of catering to a wide range of people compared to a traditional university institution. This reasoning accounts for the large number of responses for those two groups.

6. CONCLUSION

The purpose of this study was to examine the education gained by storm chasers and storm spotters and discern if this training had any effect on their geographic distribution during severe weather events. The hypothesis for this research project was that storm chasers and storm spotters who held a four year degree in the field(s) of atmospheric science and or meteorology are more willing to travel across the United States to locate, document, report, and possibly follow severe weather. Likewise, storm chasers and storm spotters not knowledgeable in the fields of atmospheric science and or meteorology, who gained their education through an organization (i.e. Skywarn, SpotterNetwork, etc.), tend to stay isolated in one geographic area.

The results from the chi-squared analysis coincided with the latter portion hypothesis while also bringing to light other statistical significances. One finding which reinforced the second portion of the hypothesis was that if more education was gained, those storm chasers and storm spotters, who did not have a four year degree from a university, would be much more comfortable documenting severe weather over a greater distance. This point reinforced the hypothesis that with more education those documenters who tend to be more geographically isolated would be willing to travel greater distances to document severe weather events. One surprising result of this analysis showed that storm chasers and storm spotters who have either a four year college education or who have taken some college courses are much more likely to associate with other storm chasers and or storm spotters who also have a background in atmospheric science and or meteorology.

One interesting result from this study showed that having a four year degree obtained from a university institution does not influence the geographic distance a severe weather documenter would travel for severe weather. Going against the main hypothesis, the correlation analysis proved that there is no statistical significance between having an educational degree and the distance one would travel to document severe weather. In fact, by using correlation analysis, it was discovered that a person's confidence in their background knowledge of atmospheric science influenced the range, both average and maximum, that they would travel to observe severe weather; more so compared to the degree a documenter possesses. Both testing methods, analysis of variance and correlation analysis, proved that there is no correlation between education and confidence level.

One major issue encountered during this study was the differences in opinion in what constitutes a storm chaser and a storm spotter and how these differences in opinion translate in the field when severe weather strikes. As mentioned previously, a storm chaser is defined as someone who observes and follows a developing thunderstorm either for educational purposes, scientific research, or as a recreational activity (Robertson, 1999). A storm spotter is defined as a volunteer or paid county or municipal employee who documents severe weather as a community service (NWS, 2007). Most storm spotters report severe weather from a fixed or strategic location around a township, city, or a state county. The issue encountered during this study centered on the translation of these definitions when both groups are present in the field, specifically storm spotters.

If a storm develops on the edge of a storm spotter's area of responsibility and this storm begins to travel across this area, the spotter is required to monitor the storm as it progresses. If this situation occurs in a county, the storm spotter may have to travel to the far edge of that county, where the severe weather is occurring, and report on the events as the storm progresses. When this situation occurs, the definition between a storm chaser and a storm spotter becomes quite vague. If a storm spotter leaves their fixed location or base of operation to monitor and follow severe weather as it travels through their area of responsibility, that storm spotter is then, by definition, a storm chaser.

Many of the survey questions used in this study were formatted to attempt to properly obtain information from both storm chasers and storm spotters without having to create a plethora of questions for each of the two groups. Several participants responded to this survey stating that storm spotters who work with the NSW never enter the field to chase severe weather. These respondents vehemently, and rather rudely, mentioned how associating a storm spotter to a storm chaser was not applicable and grossly inappropriate. In response to these comments, according to Jones and Coleman (2004), there are nine basic categories of people or groups who chase and intercept severe weather. These groups are comprised of scientists and researchers, hobbyists and amateurs, spotters, media personnel, tour groups, thrill seekers, locals, hurricane hunters, and fulltime professionals. Looking at the third example, spotters, shows the hypocrisy of the previous statement. While some people refuse to associate storm chasers with storm spotters, many others have no problem associating the two groups.

During the three week period when the distribution of the physical survey questionnaire was taking place, this question of whether there exists any commonality between storm chasers and storm spotters, and if the two can ever be the same, was discussed at length with other storm chasers and storm spotters. This discussion led to an interesting finding. The overall conclusion of these discussions was that if both storm chasers and storm spotters achieve the same goal of assisting the NWS in issuing warnings to potentially vulnerable communities from severe weather events then the issue of whether someone is a storm chaser or a storm spotter becomes irrelevant.

Going forward, this issue of storm chasers versus storm spotters needs to be addressed by the organization that benefits from the efforts of these two groups, the NWS. If this blatant pompousness is allowed to continue, the topic of storm chasers versus storm spotters will overtake the original goal and mission these two groups were found upon, warning citizens of potentially life threatening and disastrous severe weather. One recommendation to fix this issue is to do away with the titles of "storm chaser" and "storm spotter" and instead switch to one universal title. For example, by removing storm chaser and storm spotter from the meteorologic and atmospheric science vocabulary and instead switching to the title of "severe weather documenter" the animosity between these two groups can be reduced and a sense of unity and camaraderie can be established.

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APPENDIX A: SURVEY QUESTIONNAIRE

For this survey, please circle the answer which best fits your situation.

2. What is your age?
   A. 18-24
   B. 25-31
   C. 32-38
   D. 39-45
   E. Older than 46

3. Do you currently have your High School Diploma?
   A. Yes
   B. No

4. Have you ever been enrolled in a University System?
   A. Yes
   B. No

5. Are you currently enrolled in a University System?
   A. Yes (Also answer Questions 6 - 8)
   B. No (Skip to Question 9)

6. How long have you been enrolled in this University System?
   A. 1 Year or Less
   B. 2 Years
   C. 3 Years
   D. 4 Years
   E. More than 4 Years

7. What is your current program of study or major?
   A. Two Year Degree
   B. Four Year Bachelor's Degree
   C. Master's Degree
   D. Ph.D.
   E. Other (please specify)

8. How many courses have you taken in the field(s) of Atmospheric Science and or Meteorology?
   A. None
   B. 1 - 2
   C. 3 - 4
   D. 5 - 6
   E. More than 6

9. Have you previously graduated from a University System?
    A. Yes (Go to Question 10)
    B. No (Skip to Question 11)

10. With what degree did you graduate?
    A. Associates
    B. Bachelor's
    C. Master's
    D. Ph.D.

11. How long have you been a Storm Spotter/Storm Chaser?
    A. Less than 1 Year
    B. 1+ Years
    C. 2+ Years
    D. 3+ Years
    E. 4+ Years

12. Do you have any Storm Spotting or Storm Chasing Education?
    A. Yes (Go to Question 13)
    B. No (Skip to Question 14)
    C. Unsure

13. Where did you receive your Storm Spotting/Storm Chasing education?
    A. A Four Year University Institution
    B. SpotterNetwork
    C. Skywarn
    D. No Education Taken
    E. Other (please specify)

14. When Storm Spotting or Storm Chasing, are you alone? Or part of a group?
    A. Alone (Skip to Question 18)
    B. In a Group (Also answer Questions 15 - 17)

15. On average, how many Storm Spotters or Storm Chasers are part of your team?
    A. 1
    B. 2
    C. 3
    D. 4
    E. More than 4

16. Do other members of your group have any background in the fields of Atmospheric Science and or Meteorology?
    A. Yes
    B. No

17. On average, how many courses have your other group members taken in the fields of Atmospheric Science and or Meteorology?
    A. None
    B. 1 - 2
    C. 3 - 4
    D. 5 - 6
    E. More than 6

18. How confident are you in your background knowledge of Atmospheric Science and or Meteorology?
    A. Not Confident
    B. Somewhat Confident
    C. Moderately Confident
    D. Very Confident
    E. Extremely Confident

19. Why do you like to Storm Spot and or Storm Chase? (Circle ALL That Apply)
    A. Enjoyment
    B. Monetary Gain
    C. Research
    D. Experience
    E. Other (please specify)

20. What is the average distance you travel to Storm Spot and or Storm Chase severe weather in a single day?
    A. Less than 100 Miles
    B. 100-200 Miles
    C. 200-300 Miles
    D. 300-400 Miles
    E. More than 400 Miles
    Please List How Far:

21. What is the greatest distance you would travel in a single day to Storm Spot and or Storm Chase severe weather?
    A. Less than 100 Miles
    B. 100-200 Miles
    C. 200-300 Miles
    D. 300-400 Miles
    E. More than 400 Miles
    Please List How Far:

22. What are the biggest obstacles preventing you from traveling further?

23. How often do you Storm Spot and or Storm Chase throughout the year?
    A. 1 - 2 Times
    B. 3 - 5 Times
    C. 5 - 10 Times
    D. More than 10 Times

24. If given the opportunity, would you Spot and or Chase more than you do currently?
    A. Yes
    B. No

25. Are there currently any obstacles preventing you from traveling to go Storm Spotting and or Storm Chasing?
    A. Yes (Skip to Question 26)
    B. No (Skip to Question 27)

26. What obstacles are currently preventing you from traveling to go Storm Spotting and or Storm Chasing? (Check ALL That Apply)
    A. Lack of Experience
    B. Monetary Costs Are Too High
    C. Distance is Too Far
    D. Lack of Background Knowledge in Atmospheric Science
    E. Other (please specify)

27. Have you ever received monetary gain through Storm Spotting and or Storm Chasing?
    A. Yes
    B. No (Skip to Question 30)

28. How did you receive monetary gain through storm spotting and or Storm Chasing? (Check ALL That Apply)
    A. Sold Photos & Videos to a Media Outlet
    B. Sold Photos & Videos via Internet
    C. Chased Storms for a T.V. Station
    D. Gave 'Guided' Chase Tours
    E. Other (please specify)

29. Are you able to make enough money to cover your expenditures for the season?
    A. Yes
    B. No

30. If you had more education in Storm Spotting and or Storm Chasing would you be more comfortable chasing severe storms over a greater distance?
    A. Yes
    B. No (Skip to Question 32)

31. How would you gain additional education? (Circle ALL That Apply)
    - A. Enrolling in Courses at a Four Year Institution
    - B. Enrolling in SpotterNetwork Online Course
    - C. Enrolling in NWS Skywarn Program
    - D. Learning on Your Own Time
    - E. Other (please specify)

32. Other comments or issues experienced while Storm Spotting or Storm Chasing severe weather in the field

APPENDIX B: SURVEY CONSENT FORM

Survey Consent Form

This research is a survey aimed to study the distribution and movement of storm spotters and examine if the spotter's level of training influences his or her geographic chasing area. You will be asked questions about your education level and your geographic chasing area. All of your information will be kept private. It can be viewed only by authorized research staff members. The survey takes about 3 minutes to complete.

I understand that none of my answers will be released and no names will be recorded. I understand that the risks of participating in this study are minimal. I understand that participating in this study will help the researchers better understand the relationship between storm spotters and their geographic chasing area.

I understand that I can contact Dr. Donald Friend at 389-2618 or donald.friend@mnsu.edu about any concerns I have about this project. I understand that I also may contact the Minnesota State University, Mankato Institutional Review Board Administrator, Dr. Barry Ries, at 389-2321 or barry.ries@mnsu.edu with any questions about research with human participants at Minnesota State University, Mankato.

I understand that participation in this project is voluntary and I have the right to stop at any time. My decision whether or not to participant will not affect my relationship with Minnesota State University, Mankato. By completing this survey, I agree to participate in this study and state that I am at least 18 years of age. Also, I am aware that there are no direct benefits to me as a result of my participation in this research.

Participants in this study will receive for their records a copy of the consent form.

Please print this page for your records before continuing.

[ ] I am at least 18 years of age.

MSU IRB LOG # 329240-2
Date of MSU IRB approval: 4/30/2012

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APENDIX C: CHI-SQUARED ANALYSIS

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do you have any Storm Spotting or Storm Chasing Education? * Have you previously graduated from a University System?	210	100.0%	0	0.0%	210	100.0%

Do you have any Storm Spotting or Storm Chasing Education? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
Do you have any Storm Spotting or Storm Chasing Education?	No	Count	1	0	1
		% within Have you previously graduated from a University System?	1.1%	0.0%	0.5%
	Unsure	Count	1	1	2
		% within Have you previously graduated from a University System?	1.1%	0.9%	1.0%
	Yes	Count	93	114	207
		% within Have you previously graduated from a University System?	97.9%	99.1%	98.6%
Total		Count	95	115	210
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.237[a]	2	.539
Likelihood Ratio	1.613	2	.446
N of Valid Cases	210		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .45.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.077	.539
	Cramer's V	.077	.539
N of Valid Cases		210	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 1 The SPSS results of the first chi-squared analysis test. In this test the chi-squared value (1.237) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.539) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
When Storm Spotting/Chasing, are you alone? Or part of a group? * Have you previously graduated from a University System?	209	100.0%	0	0.0%	209	100.0%

When Storm Spotting/Chasing, are you alone? Or part of a group? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
When Storm Spotting/Chasing, are you alone? Or part of a group?	Alone	Count	52	62	114
		% within Have you previously graduated from a University System?	55.3%	53.9%	54.5%
	In a Group	Count	42	53	95
		% within Have you previously graduated from a University System?	44.7%	46.1%	45.5%
Total		Count	94	115	209
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.041[a]	1	.839		
Continuity Correction[b]	.004	1	.949		
Likelihood Ratio	.041	1	.839		
Fisher's Exact Test				.889	.475
N of Valid Cases	209				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 42.73.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.014	.839
	Cramer's V	.014	.839
N of Valid Cases		209	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 2 The SPSS results of the second chi-squared analysis test. In this test the chi-squared value (.041) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.839) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Have you previously graduated from a University System?	121	100.0%	0	0.0%	121	100.0%

Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology?	No	Count	36	29	65
		% within Have you previously graduated from a University System?	65.5%	43.9%	53.7%
	Yes	Count	19	37	56
		% within Have you previously graduated from a University System?	34.5%	56.1%	46.3%
Total		Count	55	66	121
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.586[a]	1	.018		
Continuity Correction[b]	4.754	1	.029		
Likelihood Ratio	5.644	1	.018		
Fisher's Exact Test				.028	.014
N of Valid Cases	121				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 25.45.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.215	.018
	Cramer's V	.215	.018
N of Valid Cases		121	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 3 The SPSS results of the third chi-squared analysis test. In this test the chi-squared value (5.586) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.018) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
If given the opportunity, would you spot/chase more than you do currently? * Have you previously graduated from a University System?	205	100.0%	0	0.0%	205	100.0%

If given the opportunity, would you spot/chase more than you do currently? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
If given the opportunity, would you spot/chase more than you do currently?	No	Count	3	18	21
		% within Have you previously graduated from a University System?	3.3%	15.7%	10.2%
	Yes	Count	87	97	184
		% within Have you previously graduated from a University System?	96.7%	84.3%	89.8%
Total		Count	90	115	205
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.333[a]	1	.004		
Continuity Correction[b]	7.047	1	.008		
Likelihood Ratio	9.375	1	.002		
Fisher's Exact Test				.004	.003
N of Valid Cases	205				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.22.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.202	.004
	Cramer's V	.202	.004
N of Valid Cases		205	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 4 The SPSS results of the fourth chi-squared analysis test. In this test the chi-squared value (8.333) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.004) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Are there currently any obstacles preventing you from traveling to go storm spotting/chasing? * Have you previously graduated from a University System?	205	100.0%	0	0.0%	205	100.0%

Are there currently any obstacles preventing you from traveling to go storm spotting/chasing? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
Are there currently any obstacles preventing you from traveling to go storm spotting/chasing?	No	Count	18	33	51
		% within Have you previously graduated from a University System?	20.0%	28.7%	24.9%
	Yes	Count	72	82	154
		% within Have you previously graduated from a University System?	80.0%	71.3%	75.1%
Total		Count	90	115	205
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.043[a]	1	.153		
Continuity Correction[b]	1.604	1	.205		
Likelihood Ratio	2.071	1	.150		
Fisher's Exact Test				.193	.102
N of Valid Cases	205				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.39.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.100	.153
	Cramer's V	.100	.153
N of Valid Cases		205	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 5 The SPSS results of the fifth chi-squared analysis test. In this test the chi-squared value (2.043) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.153) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Have you ever received monetary gain through storm spotting or storm chasing? * Have you previously graduated from a University System?	205	100.0%	0	0.0%	205	100.0%

Have you ever received monetary gain through storm spotting or storm chasing? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		
			No	Yes	Total
Have you ever received monetary gain through storm spotting or storm chasing?	No	Count	76	81	157
		% within Have you previously graduated from a University System?	84.4%	70.4%	76.6%
	Yes	Count	14	34	48
		% within Have you previously graduated from a University System?	15.6%	29.6%	23.4%
Total		Count	90	115	205
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.526[a]	1	.019		
Continuity Correction[b]	4.772	1	.029		
Likelihood Ratio	5.696	1	.017		
Fisher's Exact Test				.021	.014
N of Valid Cases	205				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.07.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.164	.019
	Cramer's V	.164	.019
N of Valid Cases		205	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 6 The SPSS results of the sixth chi-squared analysis test. In this test the chi-squared value (5.526) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.019) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Are you able to make enough money to cover your expenditures for the season? * Have you previously graduated from a University System?	57	100.0%	0	0.0%	57	100.0%

Are you able to make enough money to cover your expenditures for the season? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		Total
			No	Yes	
Are you able to make enough money to cover your expenditures for the season?	No	Count	13	30	43
		% within Have you previously graduated from a University System?	72.2%	76.9%	75.4%
	Yes	Count	5	9	14
		% within Have you previously graduated from a University System?	27.8%	23.1%	24.6%
Total		Count	18	39	57
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.147[a]	1	.702		
Continuity Correction[b]	.003	1	.958		
Likelihood Ratio	.145	1	.704		
Fisher's Exact Test				.747	.471
N of Valid Cases	57				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.42.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.051	.702
	Cramer's V	.051	.702
N of Valid Cases		57	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 7 The SPSS results of the seventh chi-squared analysis test. In this test the chi-squared value (.147) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.702) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance? * Have you previously graduated from a University System?	205	100.0%	0	0.0%	205	100.0%

If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance? * Have you previously graduated from a University System? Crosstabulation

			Have you previously graduated from a University System?		
			No	Yes	Total
If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance?	No	Count	38	78	116
		% within Have you previously graduated from a University System?	42.2%	67.8%	56.6%
	Yes	Count	52	37	89
		% within Have you previously graduated from a University System?	57.8%	32.2%	43.4%
Total		Count	90	115	205
		% within Have you previously graduated from a University System?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13.473[a]	1	.000		
Continuity Correction[b]	12.451	1	.000		
Likelihood Ratio	13.564	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	205				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 39.07.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.256	.000
	Cramer's V	.256	.000
N of Valid Cases		205	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 8 The SPSS results of the eighth chi-squared analysis test. In this test the chi-squared value (13.473) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.000) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do you have any Storm Spotting or Storm Chasing Education? * Do you have some University experience?	95	100.0%	0	0.0%	95	100.0%

Do you have any Storm Spotting or Storm Chasing Education? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		
			No	Yes	Total
Do you have any Storm Spotting or Storm Chasing Education?	No	Count	0	1	1
		% within Do you have some University experience?	0.0%	1.7%	1.1%
	Unsure	Count	1	0	1
		% within Do you have some University experience?	2.8%	0.0%	1.1%
	Yes	Count	35	58	93
		% within Do you have some University experience?	97.2%	98.3%	97.9%
Total		Count	36	59	95
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.252[a]	2	.324
Likelihood Ratio	2.896	2	.235
N of Valid Cases	95		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .38.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.154	.324
	Cramer's V	.154	.324
N of Valid Cases		95	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 9 The SPSS results of the ninth chi-squared analysis test. In this test the chi-squared value (2.252) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.324) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
When Storm Spotting/Chasing, are you alone? Or part of a group? * Do you have some University experience?	94	100.0%	0	0.0%	94	100.0%

When Storm Spotting/Chasing, are you alone? Or part of a group? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		Total
			No	Yes	
When Storm Spotting/Chasing, are you alone? Or part of a group?	Alone	Count	24	28	52
		% within Do you have some University experience?	66.7%	48.3%	55.3%
	In a Group	Count	12	30	42
		% within Do you have some University experience?	33.3%	51.7%	44.7%
Total		Count	36	58	94
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.040[a]	1	.081		
Continuity Correction[b]	2.341	1	.126		
Likelihood Ratio	3.081	1	.079		
Fisher's Exact Test				.092	.062
N of Valid Cases	94				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 16.09.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.180	.081
	Cramer's V	.180	.081
N of Valid Cases		94	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 10 The SPSS results of the tenth chi-squared analysis test. In this test the chi-squared value (3.040) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.081) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Do you have some University experience?	55	100.0%	0	0.0%	55	100.0%

Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		Total
			No	Yes	
Do the other members of your group have any background in the fields of Atmospheric Science and or Meteorology?	No	Count	16	20	36
		% within Do you have some University experience?	84.2%	55.6%	65.5%
	Yes	Count	3	16	19
		% within Do you have some University experience?	15.8%	44.4%	34.5%
Total		Count	19	36	55
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.516[a]	1	.034		
Continuity Correction[b]	3.338	1	.068		
Likelihood Ratio	4.869	1	.027		
Fisher's Exact Test				.041	.031
N of Valid Cases	55				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.56.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.287	.034
	Cramer's V	.287	.034
N of Valid Cases		55	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 11 The SPSS results of the eleventh chi-squared analysis test. In this test the chi-squared value (4.516) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.034) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
If given the opportunity, would you spot/chase more than you do currently? * Do you have some University experience?	90	100.0%	0	0.0%	90	100.0%

If given the opportunity, would you spot/chase more than you do currently? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		Total
			No	Yes	
If given the opportunity, would you spot/chase more than you do currently?	No	Count	1	2	3
		% within Do you have some University experience?	2.9%	3.6%	3.3%
	Yes	Count	33	54	87
		% within Do you have some University experience?	97.1%	96.4%	96.7%
Total		Count	34	56	90
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.026[a]	1	.872		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.027	1	.871		
Fisher's Exact Test				1.000	.682
N of Valid Cases	90				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.13.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.017	.872
	Cramer's V	.017	.872
N of Valid Cases		90	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 12 The SPSS results of the twelfth chi-squared analysis test. In this test the chi-squared value (.026) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.872) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Are there currently any obstacles preventing you from traveling to go storm spotting/chasing? * Do you have some University experience?	89	100.0%	0	0.0%	89	100.0%

Are there currently any obstacles preventing you from traveling to go storm spotting/chasing? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		
			No	Yes	Total
Are there currently any obstacles preventing you from traveling to go storm spotting/chasing?	No	Count	9	9	18
		% within Do you have some University experience?	26.5%	16.4%	20.2%
	Yes	Count	25	46	71
		% within Do you have some University experience?	73.5%	83.6%	79.8%
Total		Count	34	55	89
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.330[a]	1	.249		
Continuity Correction[b]	.778	1	.378		
Likelihood Ratio	1.303	1	.254		
Fisher's Exact Test				.285	.188
N of Valid Cases	89				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.88.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.122	.249
	Cramer's V	.122	.249
N of Valid Cases		89	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 13 The SPSS results of the thirteenth chi-squared analysis test. In this test the chi-squared value (1.330) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.249) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Have you ever received monetary gain through storm spotting or storm chasing? * Do you have some University experience?	90	100.0%	0	0.0%	90	100.0%

Have you ever received monetary gain through storm spotting or storm chasing? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		
			No	Yes	Total
Have you ever received monetary gain through storm spotting or storm chasing?	No	Count	28	48	76
		% within Do you have some University experience?	82.4%	85.7%	84.4%
	Yes	Count	6	8	14
		% within Do you have some University experience?	17.6%	14.3%	15.6%
Total		Count	34	56	90
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.182[a]	1	.670		
Continuity Correction[b]	.016	1	.899		
Likelihood Ratio	.180	1	.672		
Fisher's Exact Test				.767	.443
N of Valid Cases	90				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.29.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.045	.670
	Cramer's V	.045	.670
N of Valid Cases		90	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 14 The SPSS results of the fourteenth chi-squared analysis test. In this test the chi-squared value (.182) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.670) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Are you able to make enough money to cover your expenditures for the season? * Do you have some University experience?	17	100.0%	0	0.0%	17	100.0%

Are you able to make enough money to cover your expenditures for the season? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		
			No	Yes	Total
Are you able to make enough money to cover your expenditures for the season?	No	Count	4	8	12
		% within Do you have some University experience?	66.7%	72.7%	70.6%
	Yes	Count	2	3	5
		% within Do you have some University experience?	33.3%	27.3%	29.4%
Total		Count	6	11	17
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.069[a]	1	.793		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.068	1	.794		
Fisher's Exact Test				1.000	.605
N of Valid Cases	17				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is 1.76.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	-.064	.793
	Cramer's V	.064	.793
N of Valid Cases		17	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 15 The SPSS results of the fifteenth chi-squared analysis test. In this test the chi-squared value (.069) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.793) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance? * Do you have some University experience?	89	100.0%	0	0.0%	89	100.0%

If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance? * Do you have some University experience? Crosstabulation

			Do you have some University experience?		
			No	Yes	Total
If you had more education in storm spotting/chasing would you be more comfortable chasing severe storms over a greater distance?	No	Count	15	22	37
		% within Do you have some University experience?	44.1%	40.0%	41.6%
	Yes	Count	19	33	52
		% within Do you have some University experience?	55.9%	60.0%	58.4%
Total		Count	34	55	89
		% within Do you have some University experience?	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.147[a]	1	.702		
Continuity Correction[b]	.026	1	.872		
Likelihood Ratio	.146	1	.702		
Fisher's Exact Test				.825	.435
N of Valid Cases	89				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.13.

b. Computed only for a 2x2 table

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.041	.702
	Cramer's V	.041	.702
N of Valid Cases		89	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Figure 16 The SPSS results of the sixteenth chi-squared analysis test. In this test the chi-squared value (.147) is the first listed test in the 'Chi-Square Tests' section. The corresponding p-value (.702) is listed two columns over from the chi-squared results under the 'Asymp. Sig. (2-sided)' column.

APENDIX D: ANALYSIS OF VARIANCE

Univariate Analysis of Variance

[DataSet1]

Between-Subjects Factors

		Value Label	N
With what degree did you graduate?	1	Associates	26
	2	Bachelor's	74
	3	Master's	15
	4	Ph.D.	2

Descriptive Statistics

Dependent Variable: How confident are you in your background knowledge of Atmospheric Science/Meteorology?

With what degree did you graduate?	Mean	Std. Deviation	N
Associates	3.38	1.023	26
Bachelor's	3.50	1.010	74
Master's	3.53	.915	15
Ph.D.	4.50	.707	2
Total	3.50	.997	117

Tests of Between-Subjects Effects

Dependent Variable: How confident are you in your background knowledge of Atmospheric Science/Meteorology?

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.361[a]	3	.787	.788	.503
Intercept	359.732	1	359.732	360.091	.000
Withwhatdegreedidyougraduate	2.361	3	.787	.788	.503
Error	112.887	113	.999		
Total	1545.000	117			
Corrected Total	115.248	116			

a. R Squared = .020 (Adjusted R Squared = -.006)

Estimated Marginal Means

With what degree did you graduate?

Estimates

Dependent Variable: How confident are you in your background knowledge of Atmospheric Science/Meteorology?

With what degree did you graduate?	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Associates	3.385	.196	2.996	3.773
Bachelor's	3.500	.116	3.270	3.730
Master's	3.533	.258	3.022	4.045
Ph.D.	4.500	.707	3.100	5.900

Pairwise Comparisons

Dependent Variable: How confident are you in your background knowledge of Atmospheric Science/Meteorology?

(I) With what degree did you graduate?	(J) With what degree did you graduate?	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
Associates	Bachelor's	-.115	.228	.614	-.567	.336
	Master's	-.149	.324	.647	-.791	.493
	Ph.D.	-1.115	.733	.131	-2.568	.338
Bachelor's	Associates	.115	.228	.614	-.336	.567
	Master's	-.033	.283	.906	-.594	.527
	Ph.D.	-1.000	.716	.165	-2.419	.419
Master's	Associates	.149	.324	.647	-.493	.791
	Bachelor's	.033	.283	.906	-.527	.594
	Ph.D.	-.967	.752	.201	-2.457	.524
Ph.D.	Associates	1.115	.733	.131	-.338	2.568
	Bachelor's	1.000	.716	.165	-.419	2.419
	Master's	.967	.752	.201	-.524	2.457

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Univariate Tests

Dependent Variable: How confident are you in your background knowledge of Atmospheric Science/Meteorology?

	Sum of Squares	df	Mean Square	F	Sig.
Contrast	2.361	3	.787	.788	.503
Error	112.887	113	.999		

The F tests the effect of With what degree did you graduate? . This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

Post Hoc Tests

With what degree did you graduate?

Multiple Comparisons

Dependent Variable: How confident are you in your background knowledge of Atmospheric Science/Meteorology?
Tukey HSD

(I) With what degree did you graduate?	(J) With what degree did you graduate?	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Associates	Bachelor's	-.12	.228	.957	-.71	.48
	Master's	-.15	.324	.968	-.99	.70
	Ph.D.	-1.12	.733	.429	-3.03	.80
Bachelor's	Associates	.12	.228	.957	-.48	.71
	Master's	-.03	.283	.999	-.77	.70
	Ph.D.	-1.00	.716	.504	-2.87	.87
Master's	Associates	.15	.324	.968	-.70	.99
	Bachelor's	.03	.283	.999	-.70	.77
	Ph.D.	-.97	.752	.574	-2.93	1.00
Ph.D.	Associates	1.12	.733	.429	-.80	3.03
	Bachelor's	1.00	.716	.504	-.87	2.87
	Master's	.97	.752	.574	-1.00	2.93

Based on observed means.
The error term is Mean Square(Error) = .999.

Homogeneous Subsets

How confident are you in your background knowledge of Atmospheric Science/Meteorology?

Tukey HSD[a,b,c]

With what degree did you graduate?	N	Subset
		1
Associates	26	3.38
Bachelor's	74	3.50
Master's	15	3.53
Ph.D.	2	4.50
Sig.		.192

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = .999.

a. Uses Harmonic Mean Sample Size = 6.466.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

c. Alpha = .05.

Figure 1 The results of the One-Way, Between Groups, ANOVA analysis (p.100-102).

APPENDIX E: CORRELATION ANALYSIS

Nonparametric Correlations

[DataSet1]

Correlations

			How confident are you in your background knowledge of Atmospheric Science/Meteorology?	What is the average distance you travel to spot/chase severe weather in a single day?
Spearman's rho	How confident are you in your background knowledge of Atmospheric Science/Meteorology?	Correlation Coefficient	1.000	.346**
		Sig. (2-tailed)	.	.000
		N	208	208
	What is the average distance you travel to spot/chase severe weather in a single day?	Correlation Coefficient	.346**	1.000
		Sig. (2-tailed)	.000	.
		N	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 1 The result of the Spearman's Rank Correlation Coefficient between the two variables *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* and *What is the average distance you travel to spot and or chase in a single day?*.

Nonparametric Correlations

[DataSet2]

Correlations

			How confident are you in your background knowledge of Atmospheric Science/Meteorology?	What is the greatest distance you would travel in a single day to spot/chase severe weather?
Spearman's rho	How confident are you in your background knowledge of Atmospheric Science/Meteorology?	Correlation Coefficient	1.000	.333**
		Sig. (2-tailed)	.	.000
		N	208	208
	What is the greatest distance you would travel in a single day to spot/chase severe weather?	Correlation Coefficient	.333**	1.000
		Sig. (2-tailed)	.000	.
		N	208	208

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 2 The result of the Spearman's Rank Correlation Coefficient between the two variables *How confident are you in your background knowledge of Atmospheric Science and or Meteorology?* and *What is the greatest distance you would travel in a single day to spot and or chase severe weather?*.

Nonparametric Correlations

[DataSet3]

Correlations

			With what degree did you graduate?	What is the average distance you travel to spot/chase severe weather in a single day?
Spearman's rho	With what degree did you graduate?	Correlation Coefficient	1.000	.048
		Sig. (2-tailed)	.	.610
		N	117	117
	What is the average distance you travel to spot/chase severe weather in a single day?	Correlation Coefficient	.048	1.000
		Sig. (2-tailed)	.610	.
		N	117	117

Figure 3 The result of the Spearman's Rank Correlation Coefficient between the two variables *With what degree did you graduate?* and *What is the average distance you travel to spot and or chase in a single day?*.

Nonparametric Correlations

[DataSet4]

Correlations

			With what degree did you graduate?	What is the greatest distance you would travel in a single day to spot/chase severe weather?
Spearman's rho	With what degree did you graduate?	Correlation Coefficient	1.000	.059
		Sig. (2-tailed)	.	.526
		N	117	117
	What is the greatest distance you would travel in a single day to spot/chase severe weather?	Correlation Coefficient	.059	1.000
		Sig. (2-tailed)	.526	.
		N	117	117

Figure 4 The result of the Spearman's Rank Correlation Coefficient between the two variables *With what degree did you graduate?* and *What is the greatest distance you would travel in a single day to spot and or chase severe weather?*.