COORDINATING THE UNCOORDINATED GIANT: APPLYING THE FOUR FLOWS MODEL OF COMMUNICATIVE CONSTITUTION OF ORGANIZATIONS TO THE UNITED STATES WEATHER ENTERPRISE

Matthew Carter Rothrock

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Master's Thesis Committee

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John Parrish-Sprowl, Ph.D., Chair

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Elizabeth Goering, Ph.D.

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Ronald Sandwina, Ph.D.

DEDICATION

This master's thesis is dedicated to the version of me around the time of my quarter-life crisis. Having dreamt of studying and understanding the weather, I enrolled in Purdue University in the School of Science with the hopes of gaining a bachelor's degree in atmospheric science. Instead, I found coffee shops, friends, and diversions that seemed like a better idea than course attendance. I also found confusion, frustration, depression, and alcohol. Needless to say, that version of me flunked out of Purdue.

The thing about dreams is they do not have to die. There is hope in dreams. This dream lives, and it lives within me.

This thesis is also dedicated to my father, George Carter Rothrock (6/24/1951-8/20/2016). My application to the IUPUI Communication Studies graduate program was in process in March, 2015, when, at the end of that month, my father was diagnosed with pancreatic cancer. We were blessed to have him with us for another 16 months. I considered rescinding my application, not knowing what the future held. I told him this and he said, "It's your life and you will outlive me. This is important to you, and it's important to me, too. Go for it and don't worry about me." While I never graduated as the second generation Purdue graduate he hoped for, I instead earned his respect, and he mine, with the life I have chosen to live since I flunked out of Purdue. His support is never far, even as he is no longer with us here on Earth.

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I must also take time to thank my family for believing in education, and most importantly, supporting me in my long and winding (road?) education. My mom is a source of strength and one supportive phone call or lunch away. She let me sort through my perfectionism, procrastination, and intermittent paralysis in this process, and also was an enthusiastic cheerleader on the sidelines throughout this degree program. My father,

see above. My brother has all the degrees, teaches advanced placement classes at Noblesville High School, and now holds a master woodworker's degree as well. He has the strength it takes to beat brain cancer and still be with us. I have always loved and admired him and do so now more than ever. My sister-in-law Lindsey always has sought status updates about my coursework and continues to be an awesome mom to my niece and nephew while also being an awesome attorney in Indianapolis. My extended family has also been along for this ride and I thank them for their support.

Here, I must mention my dearest friend Anna Carmon (Ph.D., North Dakota State University, Communication Studies). Yes, this entire time I have been in the master's program, I have had a Ph.D. in my back pocket. Actually, Anna has been front and center. We became writing buddies in the strangest way this spring. She is currently engaged in research surrounding suicide obituaries. I would send her paragraphs from my application section and she would send me paragraphs from her discussion section. We would critique or affirm and send back. All spring long. She suggested an MA program for communication studies several years ago because of how the degree could translate to both public and private sector marketability, but also because she loves communication studies and it shows. Her enthusiasm rubbed off on me. My enthusiasm for coaching speech rubbed off on her, and together we raise about one to two dozen kids a year together. Without her support, I do not know where I would be today, but I do know I probably would not be finalizing this chapter called a master's degree. To think, a happy hour in April, 2011, changed the trajectory of both our lives in such significant ways.

My communities of support will be glad to know that this thesis is finished because they are so very tired of hearing me talk about it. My IUPUC work family (both

faculty and staff) have been super-supportive. My supervisors, Drs. Sandra Miles, Gary Felsten and Lori Montalbano have also rendered tremendous support for my degree pursuit. The recovery community I belong to in Columbus has also been wonderful and provided needed accountability. The community of support in the graduate program has been amazing as well. In particular, classmates Stefanie Davis, Sarah Hemmersbach, Taylor Lee, Rachel Turner, and Jalysa King helped keep me sane and on the right path. And my speech coach community, while questioning the sanity of writing a thesis, nevertheless rendered supportive comments and ideas whether I sought them or not. Student workers under my supervision often provided comic relief or unintentional distraction that helped me sort through theories and clarify my writing. All of these people propelled me forward in both small and large ways. To say that I am grateful would be a gross understatement.

Matthew Carter Rothrock

COORDINATING THE UNCOORDINATED GIANT: APPLYING THE FOUR FLOWS MODEL OF COMMUNICATIVE CONSTITUTION OF ORGANIZATIONS TO THE UNITED STATES WEATHER ENTERPRISE

The US weather enterprise includes academia, the private weather industry, and government-funded forecasting, research, and dissemination agencies. While not an organization in its own right, the enterprise behaves like an organization of organizations. This thesis applies the communicative constitution of organizations, and McPhee and Zaug's four flows model in particular, to the US weather enterprise. Each organization in the weather enterprise behaves like individual members of an organization would, which extends this theory to a conceptualization of organization that increases innovation, collaboration, and coordination. The weather is a constitutive force which calls the US weather enterprise into being. Finally, CCO is extended to other collaborative, coordinated efforts among the public and private sectors, indicating the possibilities of CCO as an attractive answer to the great organizational questions of the 21st century and beyond. Future research areas are considered, including how the US weather enterprise manages the unexpected and reduces uncertainty organizationally. Also, considerations as to how CCO can be applied to the incident command structure, often called forward during high-impact weather events, will be made.

John Parrish-Sprowl, Ph.D., Chair

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LIST OF ABBREVIATIONS

AMS: American Meteorological Society
AWC: Aviation Weather Center
AWCIA: American Weather and Climate Industry Association
AWIPS: Advanced Weather Interactive Processing System
BCE: Before common era
CBM: Certified Broadcast Meteorologist program
CCM: Certified Consulting Meteorologist program
CCO: Communicative Constitution of Organizations
CSTAR: Collaborate Science, Technology, and Applied Research program
CWSA: Commercial Weather Services Association
CWSU: Center Weather Service Unit
EAS: Emergency Alert System
EBS: Emergency Broadcast System
EMWIN: Emergency Managers Weather Information Network
FAA: Federal Aviation Administration
FCC: Federal Communications Commission
FSORE: Preoccupation with Failure; Reluctance to Simplify; Sensitivity to Operations; Commitment to Resilience; Deference to Expertise
HRO: High-reliability organizing
ICS: Incident Command Structure
IoT: Internet of things
IWS: Integrated Warning System
MPD: Mesoscale Precipitation Discussion
NASA: National Aeronautic and Space Administration
NCEP: National Centers for Environmental Prediction
NHC: National Hurricane Center
NOAA: National Oceanographic and Atmospheric Administration
NWA: National Weather Association
NWC: National Water Center
NWP: Numerical Weather Prediction
NWS: National Weather Service
QPF: Quantitative Precipitation Forecast
RFC: River Forecast Center
SELS: Severe Local Storms unit
SPC: Storm Prediction Center
SSEP: student space flight experiments program
STEM: Science, technology, engineering, and math
USWB: United States Weather Bureau (precursor to the National Weather Service)
WCM: Warning coordination meteorologist
WFO: Weather Forecast Office
WPC: Weather Prediction Center

Introduction

The weather enterprise in the United States is often described as an "orchestra without a conductor" (Pielke & Carbone, 2002). This enterprise, by necessity and contextually, is comprised of various organizations acting both in concert and independently. The organizations which make up the weather enterprise come from three distinct sectors. First, the US weather industry consists of private companies engaging in forecasting and disseminating weather information to a broad audience of stakeholders, including commercial, residential, and agricultural interests. Such organizations include The Weather Channel and AccuWeather. These private or publicly-traded companies have access to the same information and data being produced by the National Weather Service (NWS) and disseminate this information while also profiting from advertising of products and services geared towards a consumer audience. Second, the US government sector, as represented primarily by the National Weather Service, provides "foundational" data to both the US weather industry and academia ("The Weather Enterprise," 2018). Finally, academia serves as a data-gathering, research-oriented partner seeking to improve the understanding of weather phenomena, hazards, and readiness, while also training the next generation of scientists who will advance the field of meteorology. The combination of these three sectors contribute to the needs of businesses, governments, and individuals across the country.

If all of these organizations together make up the weather enterprise, how do they all work together? Since their activities are essentially unknown if not disseminated to the public, communicative activity must constitute them into not only existence but also into negotiated roles given certain situations. Communicative constitution of organizations

(McPhee & Zaug, 2000), and its four flows model in particular, is the means by which the weather enterprise communicates itself into being. Each sector of the weather enterprise, with its sub-organizations, behave as members of an organization given the four flows model.

Mass (2006) suggests competition, difficult relationships across organizations, and changes in the balance between public- and private-sector weather enterprise members are reasons why the enterprise itself is "the Uncoordinated Giant" (p. 573). The author is successful in further problematizing the lack of coordination between agencies, people, and sectors first suggested by Pielke and Carbone (2002). Both a lack of strategic planning and continued conflict as to who should be the lead on atmospheric research (Mass, 2006) are impediments to the weather enterprise deciding who their conductor will be. Technology and the evolution of scientists' understanding of meteorology coupled with the public's increased demand for increasingly sophisticated forecasts and models should naturally create opportunities for coordination and coherence in this mostly scientific community. Many of Mass' (2006) solutions to the problems of coordination and coherence are based on the primacy of the NWS over the weather reporting community. Mass' orientation (at the time of publication of the cited manuscript) is as faculty in a university atmospheric science department. Naturally, graduates of this department would go into the US weather enterprise as scientists doing research, so it is in Mass' best interest to ensure the primacy of the scientific, publicly-funded NWS and other organizations like it.

The purpose of this thesis is to suggest that the various sectors and organizations that comprise the weather enterprise, by their contextual relationships and by their orientation towards the public interest, behave like individual members of an organization would. Craig's (1999) suggestion that a working model of communication as "a constitutive process that produces and reproduces shared meaning" (p. 125) can be reflexively applied to cultures as well as considerations of theory. McPhee and Zaug (2000) theorize organizational constitution as being a communicative process. Put differently, communication-as-doing among similarly oriented individuals is a way of bringing an organization into being. By analyzing McPhee and Zaug's four flows model of communicative constitution of organizations (CCO) and applying it to the weather enterprise, CCO-as-theory will be extended into to the communicative life of the US weather enterprise. It is important to note that problematizing the weather enterprise as lacking coordination or a clear leader is a valuable exercise. This exercise opens the communication scholar to consider how and why the US weather enterprise engages in communicative activity, and it also reveals the improvements in both technology and skill which help the participant organizations and sectors work together toward a common understanding of what the US weather enterprise does. Considering organizations behaving like organizational members, the four flows model suggests there is no need for a conductor. It also finds fault with the notion that the US weather enterprise is uncoordinated.

Review of the Literature

The United States weather enterprise, as defined by the NWS, is comprised of three principal sectors: the US weather industry, government, and academia ("The Weather Enterprise," 2018). Each sector serves a role in the creation of products and services geared toward making decisions about weather and weather hazards, contributing to the overall science of weather and weather forecasting. The three sectors are interrelated and interdependent given the definition of the enterprise. The NWS also defines the US weather enterprise as a partner in its efforts to forecast, warn, disseminate, and innovate ("NWS Partners," 2017).

US weather industry

The US weather industry consists of both privately-held and publicly traded companies (Regnier, 2008). These companies are involved in the packaging, dissemination, and synthesis of weather data for specific audiences. These audiences include long-range planners in agribusiness and local government as well as other industries that are "weather sensitive" (Regnier, 2008, p. 22; "Weather Enterprise," 2018). The reason these audiences use weather information and forecasting is primarily for planning purposes. As much as $4 trillion (Regnier, 2008) of the US economy is exposed to threats from weather, so the US weather industry's role in the processes of communicating risk, forecasting hazardous weather, and packaging weather data for decision-making purposes is growing as the US economy expands. In fact, as of the mid 2000s, both the NWS and private companies are equal in terms of their size and share of the forecasting market (Mass, 2006), with NWS forecasting decreasing in proportion to the private companies. In terms of numerical weather prediction (NWP), which had solely been the province of the US military and the National Oceanic and Atmospheric Administration (NOAA), many private companies have taken on additional efforts to provide their own modeling and statistical analysis of weather (Mass, 2006). The US weather industry is characterized by both companies and trade organizations and non-profits which serve each other in the promulgation of commercial weather forecasts and information for this country's multi-trillion dollar, weather-dependent economy. Below, several of the industry associations and two companies in particular involved in the US weather industry will be highlighted.

Private weather industry in the United States is supported primarily by the American Weather and Climate Industry Association (formerly the Commercial Weather Services Association). The AWCIA is a non-profit "trade association for the professionals who make weather their business" ("What is AWCIA?" 2011). AWCIA views itself as an extension of the government-provided weather services as its member individuals and companies tailor weather data for specific uses. AWCIA is an organization by members and for members. The AWCIA website details the benefits of membership, including access to government-run weather data activities through its extension relationship. Twelve companies make up the corporate membership of the AWCIA and eleven individual members comprise the rest of the membership in the organization ("AWCIA Members," 2009). The individual members are primarily officers and administrators of the member corporations. Data links on the front page of the website all link to a document enumerating the member organizations responsible for providing data. In addition, AWCIA publicly states its support for a variety of positions, including supporting funding benchmarks for NOAA ("American Weather"). The AWCIA is termed a Friend of NOAA by ("Friends of NOAA").

One of the largest AWCIA corporate members is AccuWeather, a global commercial weather forecasting company based in State College, Pennsylvania (AccuWeather). AccuWeather provides a variety of services and products to companies, individuals, and governments across the world, including forecasts, local observations, and commercial weather information to companies and governmental agencies. AccuWeather is one of several companies which provide their information through mobile applications. They also provide their suite of forecasts, models, and other weather services to television, radio, and other media outlets as well. Much of the weather information the company provides comes from their own suite of models, observation networks, and advanced meteorological technology. However, most of the information AccuWeather packages and sells to consumers is generated from NWS modeling, forecasting, and observation. This information is also available to consumers free of charge via NWS' various web platforms. In order to distinguish itself from the NWS, AccuWeather promotes itself as a commercial weather company serving commercial interests impacted by the weather.

AccuWeather's stake in the US weather industry is significant, and its history dates back to the 1960s. The Weather Channel, first broadcast over cable in 1982 (Barnouw, 1990), also provides weather forecasting, information, and special interest programming to an audience of television viewing consumers. Scholars (Vannini & McCright, 2007; Gough, 1997) have contended such increased access to more and more media related to weather has transformed meteorological phenomena into a commodity.

Commodified media representations of the weather have become a multi-billion dollar business. The Weather Channel's evolution from a 24-hour channel of repetitive weather headlines and local forecasts during the nascent days of cable television to a sophisticated operation with its own technology for delivering forecasts and extensive coverage of breaking weather news whets the audience's appetite for instantaneous information about the weather short of opening the door and experiencing it. And, as with AccuWeather, much of the information packaged and presented on the Weather Channel is data packaged for the US weather industry by the NWS and its affiliate centers.

The similarities do not end with the usage and packaging of publicly available data for profit. Each company is significant in size and organization, employing hundreds in not just the science of meteorology, but in information technology, marketing, advertising, software development, and in telecommunications. Operational and economic diversity are means of survival for in the increasingly competitive US weather industry. The Weather Channel's parent company, the Weather Company, is the best example of this diversity. Acquired by IBM in 2015 (MacGillivray, 2016), The Weather Company's internet-based services now has access to the vast computing power of IBM's Watson and the Internet of Things (IoT). However, the televised channel has been spun off and sold to a separate company, while the Weather Company has acquired Weather Underground (a web-based real-time internet weather service run in conjunction with Intellicast) and the internet operations of the Weather Channel, weather.com (Stelter, 2012). This shifting of assets is a clear indication of the importance of increased technology at high speeds being deployed in the science of meteorology and the communication to various publics about meteorological phenomena, including smart phones. Significantly, the US weather industry's overall increased share in the science and communication of weather is directly related to the increased value the US public has placed on accurate weather forecasts. Regnier (2008) suggests the value of improvements in meteorological science spreads to other areas, "including transport, agriculture, power generation, and public emergency management" (p. 30). As the science of meteorology advances faster than its utility to stakeholders, it becomes increasingly important for the US weather industry to help stakeholders understand what the science means to their commercial, governmental, and industrial interests. The US weather industry has just begun to understand the importance of communication and tailored messaging to the aforementioned application areas.

The prevalence of media related to the weather has increased in proportion to technological improvements in telecommunications and computing. AccuWeather and the Weather Channel, two of the largest players in distributing weather information, are but a fraction of the total media related to the weather. Local television stations with news programming, who are affiliated with the major networks (ABC, NBC, CBS, and Fox), have staffs of meteorologists who help deliver weather information to the viewing areas served by the stations. The field of broadcast meteorology provides an "essential component" (Demuth, Morrow, and Lazo, 2009, p. 1614) between forecasters and the public. Further, broadcast meteorologists have the leeway to creatively package weather information into a more narrative form to enhance public understanding. Part of this creativity comes from advanced graphics and computing programs as well as suites of forecast models packaged and distributed by the US weather industry (Demuth, Morrow, and Lazo, 2009). However, the broadcast meteorology field, as part of the US weather industry, has a different relationship with the public. The audience for the televised weather information delivered daily is primarily the general public making daily decisions about how to respond to the weather as it is forecasted and presented. Further, the American public, through its communication to broadcast meteorologists, can provide nearly instantaneous feedback regarding the accuracy of weather information. This creates, as Demuth, Morrow, and Lazo (2009) suggest, an "end-to-end-to-end" process (pp. 1614-1615).

Broadcast meteorologists also must present the uncertainty of weather prediction every time they prepare a forecast for their television audience (Demuth, Morrow, and Lazo, 2009). A competitive atmosphere to deliver accurate forecasts while simultaneously reducing uncertainty creates tensions among broadcast meteorologists and between broadcast meteorologists and television viewers, especially within the same television markets. Getting viewers to watch a given weather forecast during a news program becomes a ratings-driven exercise in effectively communicating accurate forecasts while reducing uncertainty the further out the forecast goes. Demuth, Morrow, and Lazo's (2009) focus group research of broadcast meteorologists, conducted at the American Meteorological Society's (AMS) 36th Broadcast Meteorology Conference, suggests the entire system of communication between broadcast meteorologists, the US weather industry, the government-funded scientific weather community, and academia contribute to reducing forecast uncertainty. Their study focused on the role the broadcast meteorology field specifically played and exposed several avenues for empirical research. Public tolerance for forecast uncertainty varies across markets, while the broadcast meteorology field cannot necessarily agree on how much is too much communication about forecast uncertainty given time constraints put on local news programs' weather forecast segments. And, like other portions of the US weather enterprise, competition is fierce not only between television stations, but also between participants in the broader US weather enterprise (Demuth, Morrow, and Lazo, 2009).

One area of the US weather enterprise that would not seem to be in competition with the other areas is academia. While there may not be as much competition between the various atmospheric science departments at major universities across the country and the broader US weather industry, there is a tension between scientists and the media about how to communicate advances in science to the public in ways that the public understands. Another aspect of this tension is the increased influence of social science on atmospheric science vis a vis extreme weather events and human behavior. Below, academia's role in the US weather enterprise will be considered, including its partnership role with the National Weather Service and other governmental weather organizations.

Academia

Meteorology as a field of academic study has existed since the founding of the Jesuit order in Central Europe in the mid-1500s, while government-based scientific research, measurement, and forecasting can trace its roots to the turn of the 20th century (Henson, 2010; Udias, 1996). The science of meteorology has been considered since circa 2500 BCE ("Ancient"). The academic pursuit of meteorology continues to the present. The training meteorology students receive both in undergraduate and graduate programs is based on the physical science involved in weather measurement and prediction (Regnier, 2008). Over five dozen universities of varying size, prestige, and status offer at least undergraduate programs in meteorology and atmospheric science, with over half of those schools also offering post-graduate degree opportunities ("Schools"). Scholars (Mass, 2006; Regnier, 2008) suggest very little statistical modeling or stochastics training is built into their curriculum. Observation, deterministic forecasting and modeling, and multiple research agendas characterize the common meteorology and atmospheric science curriculum.

In order to create research opportunities and networking opportunities for undergraduate and graduate students in the field, the field of academia has coordinated research and internship opportunities with NOAA and NWS. Web-based resources indicate three programs that serve as a direct link between the government and academia: the Collaborate Science Technology and Applied Research Program (CSTAR), Student Employment Programs, and NOAA Cooperative Institutes ("NWS Works"). CSTAR serves to translate the applied and basic research programs of academic institutions with robust meteorology and atmospheric science departments into operational and service-based projects for NOAA and the NWS. The primary focus of this program is operational accuracy of forecasts and warnings of environmental hazards through applied research. Student Employment Programs are internship and pre-professional opportunities for students or graduates at all levels (undergraduate, graduate, professional, etc.). This includes early career service advice as well as management tracks for professional degree holders who might be interested in supervisory or management roles within NOAA or the NWS ("NWS Works," 2017). NOAA also has 16 Cooperative Institutes across the country, representing 42 research institutions and universities in 23 states and the District of Columbia ("Cooperative Institutes").

With such coordination between the public sector of the US weather enterprise and the academic interests of meteorology and atmospheric science programs across the country, an us-versus-them conflict seems to be developing between the US weather industry and the public and academic sectors. Significantly, the US weather industry giants AccuWeather and the Weather Company/Weather Channel have no available information in their web-based resources regarding the kinds of valuable connections that can be made via public and private universities and any of the NOAA/NWS programs mentioned previously. In the past decade, the level of coordination between the three parts of the US weather enterprise has improved dramatically. This will be covered in a later section of this thesis. In the upcoming subsection, the government-funded, public sector of the US weather enterprise will be defined organizationally.

Government

The publicly-funded weather forecasting, warning, and data gathering organizations are situated under the umbrella of the National Oceanic and Atmospheric Association (NOAA). NOAA is a bureau of the United States Department of Commerce ("Bureaus and Offices"). As with most other bureaus at the Cabinet level of the US government, NOAA is a byzantine bureaucracy of offices, services, and organizational charts. The primary weather service under this bureaucracy is the National Weather Service (NWS). NOAA considers the NWS a line office along with the National Environmental Satellite, Data, and Information Service; the National Marine Fisheries Service; the National Ocean Service; the Office of Marine and Aviation Operations; and the Office of Oceanic and Atmospheric Research ("Organization"). Dr. Louis Uccellini is the Assistant Administrator for Weather Services and Director of the NWS. Uccellini's deputy is Mary Erickson ("Office of the NOAA Assistant Administrator…" 2018).

The NWS serves the broader mission of the NOAA by coordinating weather information with other stakeholders in the NOAA and internationally through involvement with the World Meteorological Organization and the International Civil Aviation Organization ("Office of the NOAA Assistant Administrator…" 2018). The NWS is involved in weather covering every county and parish in the United States. Its National Headquarters, located in Silver Spring, Maryland, coordinates weather activities for six regional offices (Western, Southern, Central, Eastern, Alaska, and Pacific). These six regional offices coordinate local Weather Forecast Offices (WFOs) as well as "all operational and scientific meteorological, hydrologic, and oceanographic programs of the region including observing networks, weather services, forecasting, and climatology and hydrology" ("We Are" para. 3, 2019). The primary audiences for all of these efforts are local, state, and federal government stakeholders, private industry, and the general public.

Headquarters also supervises thirteen River Forecast Centers (RFCs) across the country ("River Forecast Centers"). These Centers monitor river and creek levels through automated, instantaneous flood gauges connected via networks. The RFCs most important task is monitoring waterways, lakes, and reservoirs for flooding and providing forecast and warning support to the public and to commercial and agricultural interests in affected watersheds. In partnership with the National Water Center (NWC), the RFCs help coordinate both long-term flood forecasting as well as drought prediction. Where the RFCs have a regional focus on flooding and droughts, the NWC serves as the nationwide water service information provider in a complementary role ("We Are" para. 6, 2019).

The NWC is also responsible for coordination of water services with local, state and national-level decision makers and emergency managers where applicable (“National Water Center”).

The NWS’s climate and environmental (planetary, synoptic, and mesoscale) prediction activities are coordinated through the National Centers for Environmental Prediction (NCEP). NCEP is the umbrella organization for nine distinct areas of science-based prediction and forecasting. These nine centers cover everything from severe weather and tropical weather prediction to space weather, aviation weather, and environmental modeling (“We Are” para. 4, 2019). As stated by the NWS’ “We Are the National Weather Service” webpage (2019), “NCEP is the starting point for nearly all weather forecasts in the United States” (para. 4). NCEP is ultimately responsible for timely, reliable, and accurate forecasts, warnings, advisories, analyses, and guidance to both the public and to US economic interests impacted by the weather. The nine centers under NCEP include the Aviation Weather Center, Climate Prediction Center, National Hurricane Center, Storm Prediction Center, Space Weather Prediction Center, Weather Prediction Center, Ocean Prediction Center, Environmental Modeling Center, and NCEP Central Operations (“We Are,” 2019).

While these national centers are at the head of the forecast, warning, and guidance, the public and the media have the most interaction and access to the WFOs. The NWS’s network of WFOs represents the smallest unit of organization for the entire government portion of the US weather enterprise. Each WFO is responsible for a local county warning area, consisting of multiple counties in the range for each office to provide accurate coverage of weather hazards and reliable forecasting. Each WFO must stay in constant communication with local emergency managers, the media, and the aviation community. Therefore, each WFO is staffed 24 hours per day, seven days per week, 365 days per year. WFOs also provide coverage for eleven NOAA Weather Radio-All Hazards stations across the country ("We Are" para. 5, 2019). The local versus national networking of services is virtually seamless in several different areas, including the concerns of pilots, airlines, and airports across the country. While the local WFOs have some stake in providing local, county-level aviation forecasts, the NWS has a national network of offices to cover the broader national air network.

Center Weather Service Units (CWSUs) coordinate aviation weather for the entire national air corridor system. The NWS deploys 84 meteorologists to 21 CWSUs across the country. These CWSUs are housed in or near the large air route traffic control centers ("We Are," 2019). These larger air route traffic control centers are typically located in large metropolitan areas across the country that handle multistate air corridors. CWSU meteorologists conduct face-to-face meetings with air traffic controllers charged with monitoring these broad swaths of the national air network and assist the Federal Aviation Administration (FAA) in keeping the air system moving effectively around weather and major turbulence hazards. Meteorologists also issue forecasts and weather updates every two hours ("We Are"). In coordination with the Aviation Weather Center (AWC), CWSUs can issue regional advisories regarding turbulence, icing conditions, thunderstorms, and wind shear, all of which can create performance problems for aircraft flying at various altitudes. The Aviation Weather Center is responsible for notifying pilots and air traffic controllers of regional advisories, in addition to publishing pilot reports of turbulence, icing, choppiness, or wind shear. The AWC does this at the national level, since its responsibility is weather forecasting and observation for the entire US air network ("Aviation Weather Center," 2013).

This maze of organizations in an already significant bureaucracy engages in the daily activity of observing, predicting, and warning against hazardous weather, while simultaneously engaging in data collection for climate research. The coordination required between agencies of the NWS is significant. In addition to the coordination between WFOs, the NCEP offices, the aviation weather community, and the RFCs, the government sector of the US weather enterprise must communicate the result of all this activity to the other sectors of the enterprise as well. The general public and other stakeholders rely on accurate and timely weather prediction for their personal or business activity. Each part of the US weather enterprise—the US weather industry, academia, and government—must coordinate their activities before they can effectively package and distribute weather information to their constituent publics.

Coordination takes place in the communicative activity both within and between the sectors of the US weather enterprise. In a much broader context, the US weather enterprise communicates itself into being. The messages generated by the organizations within the enterprise are unique to the enterprise and its members, are held together with common language, and are called upon by various publics to be accurate and reliable all at the same time. Coordination of the various parts of the enterprise cannot take place without the enterprise first being constituted into being through communication. McPhee and Zaug's (2000) communicative constitution of organizations (CCO) serves as the framework most applicable to the way the US weather enterprise constitutes a larger organization made up of smaller organizations coordinating their activities with multiple goals in mind for multiple audiences or publics. Instead of an orchestra not playing together and making beautiful music, the enterprise arranges its activities in such a way that neither note nor beat is missed in the process of helping Americans understand what is going on outside their windows.

Communicative constitution of organizations (CCO)

McPhee and Zaug (2000) suggest CCO first is an acknowledgement of Weick's (1979) approach to organizing being a dynamic process. This dynamic process leads to sensemaking, defined as "communication behavior designed to reduce ambiguity" (Griffin, Ledbetter, & Sparks, 2012, p. 256). McPhee and Zaug suggest four truths about the communicative constitution of organization: first, that communication reduces ambiguity in the process of organizing and in organizations themselves, but also that communication has constitutive force; second, complex organizations or organizations relating to outside objects beget increased complexity in processes of organizational communication; third, some communication within organizations, such as chats with friends or coworkers, is not inherently organizational; and finally, communication constituting organizations happens in broad, but clear processes (McPhee & Zaug, 2000). Ultimately, "[o]rganizations are a social form created and maintained by manifestly and reflexively reifying practices of members—the members think of, treat, and relate to organizations as real, higher-order systems, and make provision for their survival" (McPhee & Zaug, 2000, p. 6).

McPhee and Zaug (2000) answer the question of how such constitution happens with the *four flows model* of CCO. These four flows "link the organization to its members (membership negotiation), to itself reflexively (self-structuring), to the environment (institutional positioning)… to adapt interdependent activity to specific work situations and problems (activity coordination)" (McPhee & Zaug, 2000, p. 7). *Membership negotiation* is the means an organization uses to regulate who is a part of an organization and who is not. In most organizations, this flow is communicated at entry to an organization and leads to socialization and informal linkages (Griffin, Ledbetter, & Sparks, 2012). This flow also privileges the relation of the communicators to the organization, that human agency is the reason organizations exist in the first place. *Organizational self-structuring* creates the organization into being and shapes the relationships of the organization's members (Griffin, Ledbetter, & Sparks, 2012). Documents chartering organizations, like constitutions, bylaws, and organizational charts are part of this process, as are hierarchical relationships and budgeting--anything that serves to steer an organization. Self-structuring, according to McPhee and Zaug (2000) is also "an interpretive and political process, stuck in socioeconomic traditions that…favor corporate bureaucracy" (p. 9). *Activity coordination* refers to the activities organizations engage in which separate them from basic groups of people. Typically, organizations are constituted to achieve a goal or goals. In organizations, hierarchies are not always understood, relationships are not clearly defined, and self-structuring is ambiguous on occasion. Activity coordination accounts for adjustments in these self-structuring practices in order to achieve the purpose of the organization (McPhee & Zaug, 2000). Finally, *institutional positioning* deals with communication outside an organization—other organizations or people who encounter the organization. This flow suggests an organization responds to and reacts to its environment through outgoing and incoming communication with external constituencies (McPhee & Zaug, 2000; Griffin, Ledbetter, & Sparks, 2012).

In order to understand the US weather enterprise, CCO may be a useful framework for how the three parts of the enterprise work as an organization of organizations, because of the complexity of the relationship between the three sectors as demonstrated above and due to the mutuality of any given task ascribed to it. While various organizations within the enterprise seem to be the ones responsible for coordinating the efforts of other parts of the enterprise, the role of communication between enterprise members is neither particularly well documented nor apparent to the communication scholar. Significantly, it is not always apparent to some of the members themselves (hence the references to the orchestra without a conductor or the uncoordinated giant). If the members of member organizations are not clear as to how the weather enterprise communicates or coordinates, then perhaps a new framework or way of thinking and knowing about organizations is necessary. Therefore, the following research question is proposed: In what way does the United States weather enterprise represent the communicative constitution of organizations as a perspective? This thesis will consider the weather enterprise in its engagement of the four flows model of the communicative constitution of organizations.

Method and Application

Barge and Craig (2009) make three conclusions about applied communication scholarship in their study of practical theoretical approaches. First, as the diversity of approaches used in applied scholarship increases, grounded practical theory becomes more established. Second, developments of communication theory can be tied directly to applied research. Finally, when considering theory, scholars and practitioners have sought readily usable or practical approaches to both research and application (Barge & Craig, 2009, p. 58). In the case of the United States weather enterprise, applying the communicative constitution of organizations (CCO), and the four flows model in particular, will contribute to our epistemological understanding of organizations and, significantly, organizations of organizations. McPhee and Zaug (2000) make the following implications regarding the four flows: 1) that constituted organizations are not just sets of flows, but the constituted organization is a complex relationship of the flows; 2) the four flows are both related and different; and 3) constitution is not automatic when the four flows are present. In particular, the US weather enterprise is a constituted organization made up of organizations, which is communicated into being while simultaneously flourishing without any kind of hierarchy. Such an application of CCO as a perspective might illuminate other such connections between linked organizations in other contexts.

To broaden this understanding, Putnam and Nicotera (2010) suggest there are three meanings to the term *organization*: "organization as object (entity), organization as a perpetual state of change or becoming (process), and organization as grounded in action (entity from process)" (p. 159). The authors contend that previous critiques of CCO and the four flows stem from limited considerations of the definition of the term *organization*. In order to consider the US weather enterprise as an organization defined through the four flows, considerations of all three conceptualizations of organization listed above should be made. CCO provides multiple entry points for how and why communication constitutes organizations into being. Further, as Cooren, Kuhn, Cornelissen, and Clark (2011) argue, “CCO scholarship should be as inclusive as possible about what [is meant] by (organizational) communication” (brackets added) (p. 1151). Since no clear hierarchy exists in the US weather enterprise, comparisons to other successful organizations without hierarchical structures is perhaps necessary to understand why an organization of organizations communicates itself into a vaunted and well-known enterprise.

The application of the four flows model will be presented sequentially, even though they may not occur sequentially, based on previous research (Cooren, Kuhn, Cornelissen, & Clark, 2011; Griffin, Ledbetter & Sparks, 2015; Putnam & Nicotera, 2010). McPhee and Zaug (2009) suggest there are four principles that direct the four flows. First, all four flows are necessary for organization; second, different flows happen in different places; third, the same message can address multiple flows; and finally, different flows address different audiences. In other words, while all four flows do constitute organizations, in this case the US weather enterprise, they do not occur in a vacuum. Further, similar examples of how various sectors of the enterprise interact with each other may serve to illuminate more than one flow. Being a member of the US weather enterprise has implications both for individuals and for other organizations. What defines membership in the enterprise and how individuals and organizations navigate the enterprise will be considered below.

Membership negotiation

The four flows model establishes organization and communication as equivalent (McPhee & Zaug, 2000). In the four flows, membership negotiation relates members to their given organization through the processes of communication and constitution. By extension, member organizations of the United States weather enterprise, through communication, comprise a significantly larger organization through membership negotiation on a much larger scale. As the public's appetite for weather information has increased, as population levels have increased, and as the US weather enterprise's understanding of meteorological phenomena has increased, more resources are being leveraged from not only the public, governmental side of the enterprise, but also from the private weather industry and broadcast media. In this sense, the National Weather Service (NWS) itself calls the enterprise into being by calling the private weather industry and broadcast media "partners" in the forecasting and dissemination process. Significantly, the NWS relies on the private weather industry and broadcast media to replicate its work product, namely forecasts, warnings, advisories, and other timely information to help the public and commercial interests make decisions. Similarly, the information received from the NWS is often translated into audience-dictated, packaged forecasts, decision-support dashboards, and other specific formats for consumers and industrial interests. These interests tend to be the province of the private weather industry and their similarly affiliated trade organizations.

As the American Weather and Climate Industry Association (AWCIA) is the trade organization of the private sector of the US weather enterprise, two organizations with significant histories and memberships provide a site of membership negotiation for all three sectors (private weather industry, academia, and government-funded)—the American Meteorological Society (AMS) and the National Weather Association (NWA). The AMS' mission statement is "[to advance] the atmospheric and related sciences, technologies, applications, and services for the benefit of society" ("About the…"). Founded in 1919, the AMS serves both the scientific and professional needs of the total fields of meteorology and atmospheric science. The AMS is also responsible for the publication of 12 different academic journals and periodicals geared towards both scientists and other professionals.

Perhaps the most famous or widely known role of the AMS is its robust professional certification programs. The first of these certifications began nine years after the birth of television. The AMS Seal of Approval program, started in 1957, recognized on-air meteorologists "for their sound delivery of weather information to the general public" ("AMS Professional…"). As television news put increasing focus on delivering quality weather forecasts and information, the AMS seal of approval became a source of boosted ratings, especially if an entire team of meteorologists was so certified (Freedman, 2006). Initially, meteorologists seeking certification had to submit an application and a fee for evaluation by the AMS board. They also had to submit a tape of their work, demonstrate some level of education in meteorology, and pass a written exam in order to earn the Seal (Jehn, 1959). Candidates for seals were judged in four areas: informational value (technical excellence of presented information); audience interest (a combination of well-organized information and the personality of the broadcast meteorologist); educational value (explained the how and why of weather well); and professional attitude (recognition of the performer's status and the prestige of the field as an emerging science)

(Jehn, 1959). The AMS Seal of Approval incentivized television stations to hire competent professionals to deliver a weather forecast (Freedman, 2006). Eventually, the Seal program evolved into the Certified Broadcast Meteorologist program (CBM), effective January 1, 2005 ("Certified Broadcast…"). This evolution of the AMS' professional certification happened as the field's understanding of meteorology and the advances in technology used to help the public make decisions also increased.

As the technology related to weather observation, prediction, and modeling has increased, the job of broadcast meteorologist has become more complex. This increase in the technology has also led to the increase in the understanding of the atmosphere and the science related to it. The requirements of the job of broadcast meteorologist have moved with the times as well. The CBM program requires broadcast meteorologists seeking certification to possess degrees in meteorology or atmospheric science ("Certified Broadcast…"). Since many meteorology and atmospheric science faculty also possess memberships in the AMS, it is their responsibility to educate and graduate prepared meteorological professionals. These professionals, whether being on-air talent or government-funded scientists, become members of the AMS and seek certifications, ensuring the survival and promulgation of the AMS writ large. The AMS advertises the program as one where prospective CBMs earn the respect of their colleagues and the general public, join professional communities both in social media and in newsletter formats, become the on-air station scientists due to the CBMs' extensive science background, gain competitive edge over other non-CBM candidates for jobs, and receive professional development and continuing education throughout the process ("Certified Broadcast…"). This is an intersection of academia and broadcast meteorologists negotiating membership into the broader US weather enterprise through a certification and socialization program from one of its more renowned professional organizations. For non-broadcast meteorologists, the AMS also provides a similar credentialing program. The Certified Consulting Meteorologist (CCM) program is a means for meteorologists who consult with both the public (either directly or through government agencies) and private industry. Certification benefits for the CCM program are advertised using identical messaging as the CBM program noted above. Both the CBM and CCM programs represent more than $1 billion of the market share of the US weather enterprise (Spiegler, 2007) and thus suggests the emergence of the private sector/private weather industry.

The National Weather Association (NWA) also provides similar membership negotiation practices for "operational meteorologists" ("About NWA," 2016). Its mission is "[c]onnecting operational meteorologists in pursuit of excellence in weather forecasting, communication, and service" ("About NWA," 2016). Similar to the AMS, the NWA publishes a journal and a member newsletter. The NWA has a similar Seal of Approval program for on-air broadcast meteorologists with similar criteria for selection. However, the NWA also has a Digital Seal of Approval to combat the potential misinformation which may arise from non-certified internet sources and weather blogs, "separating the professionals from the amateurs" (NWA, 2014). The intersectionality of broadcast meteorologists and operational meteorologists is notable in its contrast to the AMS, where the intersectionality tends toward academia and the broadcast meteorology field.

Representatives of the organizations that comprise the weather enterprise who interact in such settings as the AWCIA, the AMS, and the NWA are involved in membership negotiation as individuals. By extension, organizations become member organizations of the larger US weather enterprise through the interactions of their individual representatives in these settings. Since the AMS and NWA have annual meetings, regional chapters, committees, and executive boards, and since these trade organizations also have membership benefits not unlike workplaces, academic conferences, and other trade organizations, the combined participation of the various individual representatives of these organizations bring forth the organizations for some negotiated role in the broader US weather enterprise. Furthermore, by the very nature of these interactions, the US weather enterprise negotiates which organizations become member organizations through these various forms of participation.

Deciding who belongs in the US weather enterprise is not made by any one single organization or any one single person. Any individual can join the AMS or NWA. While consumers cannot join the NWS per se, they can become part of the group of people who help the enterprise function. Therefore, they become an organization that functions as part of the broader enterprise. The NWS delivers its work product (forecasts, warnings, advisories, and climate information) to various publics though its weather forecast offices (WFO) and centers, as indicated above. Its WFOs can coordinate with the Storm Prediction Center or one of the other national centers on severe weather or flooding or the Weather Prediction Center on major winter storms. They can use climate data to craft messages regarding departures from average (rainfall, temperatures, snowfall, etc.) over the course of a season. Much of the messaging coming from the NWS and its WFOs and centers is geared towards a public making decisions where weather might have an impact. Through the NWS' partnership with broadcast media, these messages also are transformed into an appropriate form for a television-viewing audience. Weather consumers can informally help the broader enterprise by relaying, either on their own or through emergency management, reports of severe weather, heavy snow, or other extreme events to both the broadcast media and local NWS office. Even some of the mobile weather apps have crowdsourcing capabilities for easy reporting of basic weather information experienced by consumers.

In severe weather (thunderstorms with hail, high wind, tornadoes, flash flooding, and frequent lightning), networks of amateur radio operators become storm spotters who can report to the NWS WFOs and broadcast media conditions at any given point in a broad forecast area. McCarthy (2002) suggests that the May 3, 1999, tornado outbreak, which included the massive Moore, OK, tornado, could have been significantly more deadly had it not been for the combined efforts of the NWS WFO in Norman, OK, the broadcast media and radio reporting, and the 100 spotter reports of severe weather over amateur radio. Spotter networks serve a dual purpose. First, they operate in formal and informal networks to serve their friends and neighbors, and they also serve the weather enterprise through their training. This training usually takes place in every county of a given WFO. "Hundreds of storm-spotter classes are conducted every year by meteorologists and technicians from NWS WFOs around the United States" (McCarthy, 2002, p. 647). In addition, these spotter classes are conducted in conjunction with local emergency management officials who also have spotter training and first responder responsibilities during natural disasters (McCarthy, 2002). The WFO calls the spotter network into being as a member of the weather enterprise through its own training and teaching.

The NWS formalized the spotter networks into the SKYWARN program. SKYWARN claims roughly 350,000 to 400,000 spotters ("NWS SKYWARN…") across the United States, making it perhaps the largest organization in the entire US weather enterprise. Their main responsibility is identifying and describing severe local storms. Anyone with an interest in public service is welcome to become a spotter, but mostly public safety officials, company safety officers, hospital officials, and first responders take the classes. It is important to note that SKYWARN spotter classes are taught by NWS warning coordination meteorologists (WCMs) from the local WFOs. This is another site of membership negotiation, where initiation into the broad spotter network is controlled somewhat by the NWS through a curriculum and intentional messaging about the importance of reliable dissemination of information about severe local storms. Since many of the spotters are also first responders and public safety officials, they further add to the membership of organizations which comprise US weather enterprise where necessary. They coordinate their activities through communication and call themselves forward into the US weather enterprise on an event-by-event basis.

These examples of membership negotiation involve the use of messaging and dissemination in order to regulate who belongs in the weather enterprise, who can self-select to become a part of the weather enterprise, and who can arrange themselves into a network in service to the weather enterprise. The messages themselves and the way they are disseminated can be considered part of the work product, or as "communication acts that birth an organization" (Griffin, Ledbetter, & Sparks, 2015, p. 258). Further, every organizational chart from the National Oceanographic and Atmospheric Association (NOAA) which describes how the US weather enterprise functions in the broader US Department of Commerce, or every webpage documenting the way the NWS communicates with and considers their partners, establishes structurally the activities of the various parts of the US weather enterprise. Indeed, the US weather enterprise self-structures every day across all of its member organizations. In the past several years, it has also restructured to make room for an increasingly robust private weather industry and for advances in technology. Determining how a global and local, public and private, planetary and microscale enterprise communicates its lifeworld is done through self-structuring.

Self-structuring

Atmospheric science scholars (Mass, 2006; Pielke & Carbone, 2002) contend that the US weather enterprise is an orchestra without a conductor and an uncoordinated giant. Instead, the US weather enterprise is a broad organization made up of other organizations, which are constituted through negotiated roles. As members and member organizations negotiate their roles in the US weather enterprise, they structure themselves through communicative acts. Self-structuring (McPhee & Zaug, 2000) is first a communication process between people or groups of people, especially those playing certain roles in an organization. By extension, a well-defined and broad enterprise, such as the US weather enterprise, also reflexively self-structures in order to function. Cooren and Fairhurst (2004) suggest that, across organizing schemes both inside and outside organizations, openings occur for shared meaning and understanding in the communication that occurs between members and external stakeholders and among members and external stakeholders. If member organizations in the US weather enterprise are constituted through their communication, then they must also seek closure (Cooren & Fairhurst, 2004), or a shared understanding, of the how and why of forecasting, disseminating, warning, and advising in order to become the enterprise writ large. Thus, self-structuring helps us understand what the various member organizations do in their communication without an obvious hierarchy in place. McPhee and Zaug (2000) suggest self-structuring "distinguishes organizations from groupings such as lynch mobs or mere neighborhoods" (p. 8). Similarly, Griffin, Ledbetter, and Sparks' (2015) analysis of self-structuring and closure in their chapter regarding CCO and the four flows indicates closure as the means for organizations covering a broad geographical area to communicate the structure, citing fraternities and sororities among other organizations in their examples.

Since weather impacts every single square mile of the United States and its territories, any organization or grouping of organizations must self-structure in certain ways to deliver the necessary information to the people and institutions who will be impacted by it. In a further section, the application of activity coordination as one of the four flows of CCO will illuminate the importance of self-structuring and the interrelatedness of these two particular flows. Organizations tend to have an audience, a customer base, a purpose or mission, and/or a set task which create the opportunities for communication activity geared toward self-structuring. Groups of organizations under the umbrella of the US weather enterprise have multiple audiences, multiple customer/consumer bases, various purposes and missions, and/or numerous set tasks to deliver its work product. Further, charters for the trade and professional organizations and mission statements for every publicly funded center and department of NOAA communicate how the various sectors of the US weather enterprise are to function and engage with other sectors and organizations. For example, the various centers of the National Weather Service self-structure in order to coordinate their activities and identify both internal and external audiences for their forecasts, as well as partner organizations to help make those forecasts. Below, the Weather Prediction Center's communication activity pertaining to closure will be considered.

The Weather Prediction Center (WPC) is a part of the National Centers for Environmental Prediction (NCEP), which is a center under the NWS. Its mission is to serve "as a leader in the collaborative weather forecast process by delivering responsive, accurate, and reliable national forecasts and analyses" ("About the WPC," 2004). The primary functions of the WPC are to produce Quantitative Precipitation Forecasts (QPFs), Mesoscale Precipitation Discussions (MPDs), winter weather forecasts, short term forecasts (6-60 hours), medium range forecasts (three to seven days), Alaska medium-range forecasts (four to eight days), numerical model interpretation, surface analysis, and tropical cyclone forecasts. The WPC also staffs international desks to train Central and South American meteorologists in Numerical Weather Prediction (NWP) and coordinate with meteorologists in the Caribbean and Central and South America on QPFs related to tropical cyclones ("About the WPC," 2004).

This grouping of functions centers the WPC in the daily national forecasting conversation taking place between all the various organizations comprising the US weather enterprise. Indeed, in an internet-based 2014 overview, the WPC states that it is the "[s]tarting point for local forecasts" ("Center Overview," 2014). Additionally, the

WPC situates itself as both the unifying influence and a focal point for national forecasting and NWS collaboration ("Center Overview," 2014). Perhaps most importantly, the WPC provides redundancy to other centers should those other centers go offline for any reason ("Center Overview," 2014). By communicating both its centrality to the publicly funded, government-based weather forecasting community and its role as a starting point for all US weather forecasting, the WPC has self-structured into the clearinghouse of all NWS daily forecasting activity, which is no small task. Significantly, the WPC calls other parts of the US weather enterprise into being through enumerated partnerships which are a natural progression from being the national forecasting clearinghouse. All NWS field office operations (WFOs, River Forecast Centers, and Center Weather Service Units), the other seven centers under NCEP, federal agencies (the Department of Homeland Security, the Federal Emergency Management Agency, and the United States Agency for International Development), state disaster agencies, the private sector, broadcast media, and academia all count as partners and customers of the WPC. Notably, the WPC does not delineate which count as partners and which count as customers of the WPC. Indeed, McPhee and Zaug (2000) make the contention that "self-structuring communication is subject to…ambiguity" (p. 9). And while the authors further state that "[i]t is an interpretive and political process, stuck in socioeconomic traditions that…favor corporate bureaucracy" (McPhee & Zaug, 2000), the WPC seems to interpret their role in such a way as to reduce bureaucracy by how they structure themselves in the broader public portion of the enterprise.

Through this self-structured role, which evolved over time as the US weather enterprise and the NWS specifically evolved, the WPC produces the forecasts, discussions, and other products created by the US weather enterprise and for the US weather enterprise. In coordination and communication, regular forecasts and other forms of prediction are the artifacts, which create the closure opportunities cited above. Naming itself the starting point of local forecasts, the WPC is not located at the top of any organizational chart and eschews any kind of hierarchy. One particular example of this is its role serving as the backstop for a lateral organization under the NCEP, the National Hurricane Center (NHC). When a hurricane makes landfall in the United States, the NHC will hand off the tracking, forecasting, and dissemination of information on the storms to the WPC. This is done as the threats to land shift from wind, storm surge, and brief tornadoes to torrential rains over broad swaths of land. In fact, the WPC ("About the WPC") provides the rainfall forecast to the NHC for each hurricane forecast advisory issued even before the hurricanes make landfall. In that regard, the WPC is a partner of the NHC.

Landfalling hurricanes are always high-impact events for meteorologists at the NHC and the WPC. They are also high-impact events for broadcast media. The primary national weather channels, AccuWeather and The Weather Channel, following the lead from 24-hour cable news networks (such as The Weather Channel's former corporate sibling, CNN), create commodified spectacles of the weather (Vannini & McCright, 2007). These representatives of the private US weather industry self-structure into aggregators of weather-as-narrative and weather-as-news. A recent stretch of weather in May 2019 has captured the nation's attention as fourteen consecutive days of severe thunderstorms and flooding have occurred with large tornadoes affecting major metropolitan areas, such as Dayton, OH; Kansas City, MO; Chicago, IL; Oklahoma City, OK; and outside Indianapolis, IN. These headline-making events become web-based content pushed by both AccuWeather and The Weather Channel. Indeed, these two organizations serve to communicate what they believe counts as news and then leverage narratives about major weather events and natural disasters, providing context and historical information to situate the current weather story into a national conversation. These narratives create a simulated weather experience for any consumer of weather information, as only someone out in the weather can actually experience the weather in real time.

Whether it is broad severe weather outbreaks, blizzards, hurricanes, flash floods, heat waves, or a polar vortex, the US weather enterprise self-structures through not only its already negotiated roles, but also through established organizational structures which are hierarchical in nature. This is not to say that the US weather enterprise is a hierarchy. This thesis would be moot if that were the case. However, understanding the need of especially the government-funded aspect of the US weather enterprise (NOAA, NWS, etc.) to structure itself as an agent of a dizzying bureaucracy helps lend both certainty and closure to the rest of the US weather enterprise. The organizational charts, strategic plans, and foundational documents of the publicly funded sector of the enterprise, as McPhee (2015) states, "[inscribe] the organization in enduring, controlling texts, or… in the chains of decisions that absorb uncertainty in the organizational system" (p. 489). On the other hand, many of the texts produced by the enterprise are ephemeral in nature, as a forecast is only valid through a given timeframe, when another forecast is made. Watches and warnings for hazardous weather are valid for specific and comparatively short periods of time. Weather events as news are archived by the private weather industry or transformed into event summaries by the NWS and its centers and offices. The structure of the weather enterprise tends toward the current and the future, with only certain sectors and member organizations concerned with patterns, climate, and past weather. Therefore, the enterprise's self-structuring orientation is towards managing the uncertain and attempting to understand better the science behind the forecast in order to reduce uncertainty. The US weather enterprise self-structures in order to lend certainty to what is, notably, an uncertain activity.

The interrelatedness of (reflexive) self-structuring and activity coordination is significant, and it is difficult to discuss only self-structuring and the weather enterprise without considering self-structuring as both an antecedent and a result of activity coordination. The US weather enterprise is driven by consistent, daily activity, and the efforts of various sectors and organizations in the enterprise are simultaneously predicting, responding to, simulating, and cataloguing the weather experienced by the general public in the United States. The coordination of activities through communication impacts how the organization of organizations self-structure (and, indeed, who is called forward as member organizations of the enterprise for that particular activity). Below, the third flow of activity coordination will be considered in relation to both high-impact weather events and other situations requiring cross-sector or cross-organizational engagement.

Activity coordination

If organizations have at least one manifest purpose, as McPhee and Zaug (2000) suggest, then the US weather enterprise is an organization of organizations communicated into being through multiple manifest purposes. In reflecting CCO as a perspective, the US weather enterprise engages in interdependent activities to forecast, analyze, and alert the public about weather across the country. In some cases, the enterprise considers the climactic and planetary level of meteorological understanding in its work to help the public and private sectors understand and take action in hazardous or non-hazardous weather situations. Indeed, as Griffin, Ledbetter, and Sparks (2015) affirm, “effective activity coordination can save lives” (p. 260). Activity coordination is constantly taking place, with the enterprise having already self-structured as a response to planetary patterns, large-scale features (synoptic), local storms (mesoscale), and specific meteorological events (microscale). It presumes self-structuring (Griffin, Ledbetter, & Sparks, 2015).

One area where multiple organizations and their representatives have coordinated their activities is in the dissemination of tornado warnings. It is implicit that the antecedent act of self-structuring means that every organizational member involved knows what every other organizational member is doing (Griffin, Ledbetter, & Sparks, 2015). Therefore, the warning for a tornado or severe local storms associated with tornadoes must involve activity coordination of interrelated and interdependent organizations working as one to inform the general public of not only an actual tornado event, but also the likelihood of a severe local storm producing a tornado at one to eight days prior. Doswell, Moller, and Brooks (1999) first suggest activity coordination in an integrated warning system (IWS). In their analysis, the authors make the case that, as the scientific knowledge and skill of warning for tornadoes has increased, the number of fatalities from tornadoes has decreased. Such an IWS “consists of the four basic elements: *forecast, detection, dissemination,* and *public response*” (Leik et al. 1981 qtd.

in Doswell, Moller, & Brooks, 1999). Here, the activity coordination flow is exactly how this integrated approach works across the various organizations in the US weather enterprise. Two specific goals emerge from this activity: saving lives and reducing uncertainty in a meteorological event which has long been associated with death and unpredictability.

Coleman, Knupp, Spann, Elliott, and Peters (2011) document each of the history, present, and future of tornado warning dissemination. Their research determined the modern era of tornado warning started after the successful experimental deployment of a tornado forecast and warning at Tinker Air Force Base, OK, on March 25, 1948. Up to around 1950, mentioning the word *tornado* in a forecast had been forbidden since 1887, due to the fear that such language released to the public would induce panic or hysteria (Coleman, Knupp, Spann, Elliott, & Peters, 2011). As the public welter for tornado warnings grew based on wide reports of the success of the tornado warning forecast at Tinker, the US Weather Bureau (USWB—the precursor to the National Weather Service) lifted the ban on July 12, 1950 (Coleman, Knupp, Spann, Elliott, & Peters, 2011). At the same time, the first storm spotter networks and weather radar were being deployed to help in the forecasting and understanding of tornadoes, which, as with so many other unknown weather phenomena, came without warning and often maimed or killed. Couple this with the activities of the Severe Local Storms (SELS) unit of the USWB, which created tornado forecasts covering broad swaths of land, and the USWB's adoption of the tornado warning in 1965 (Coleman, Knupp, Spann, Elliott, & Peters, 2011; Doswell, Moller, & Brooks, 1998), and the need to coordinate all of this forecasting and warning activity became clear.

As McPhee and Zaug (2000) note, activity coordination often reifies the informal nature of organizing that sometimes develops in the out-of-the-ordinary problems, which develop in the process of constituting organizations. The US weather enterprise went in reverse, starting with a phenomenon that was unpredictable and deadly, and coordinating its activities in response. The enterprise itself was constituted in the space of problematizing and disseminating high-impact meteorological events to mitigate death and destruction. In the process of understanding and perfecting tornado prediction and warning, the enterprise brought the broadcast media forward to serve as a part of the enterprise by relying on their networks to disseminate warnings to the public and to the private commercial sector. The broadcast media received warning information in a variety of forms, including local and eventually national wire and teletype services, telephone hotlines, and finally satellite and computerized weather warning software (Coleman, Knupp, Spann, Elliott, & Peters, 2011). The current form that the NWS uses is the Advanced Weather Interactive Processing System (AWIPS) (Coleman, Knupp, Spann, Elliott, & Peters, 2011). AWIPS issues its warnings through the NOAA Weather Wire Service, the Emergency Managers Weather Information Network (EMWIN), and other conduits, including NOAA Weather Radio (Coleman, Knupp, Spann, Elliott, & Peters, 2011).

Broadcast media deploy warnings usually through the Emergency Alert System (EAS), which is a system that provides a direct line of communication from the President to the American public. This network is designed for national emergency situations (previously the Emergency Broadcast System, or EBS). Local broadcasters can use EAS, though, as a means of broadcasting directly tornado warning or other high-impact weather information to its viewing or listening area (Coleman, Knupp, Spann, Elliott, & Peters, 2011). One of the reasons that such conduits exist is due to the Federal Communications Commission rules regarding operating in the public interest (FCC, 2018). Local EAS plans are regulated by the FCC, but the federal government does not require by law that broadcast media deliver tornado warnings. Here, the FCC is slightly more explicit with its ever evolving public interest standard, and television and radio station licensure is dependent upon such operational standards. This is not to say that suddenly the FCC is part of the US weather enterprise. However, the FCC public interest standard is a current site of activity coordination between the NWS and the broadcast media partners and meteorologists, with the results of this coordination being the effective dissemination of emergency information to the public.

Broadcast media also use a variety of means to deliver tornado warnings without interrupting normal broadcasting schedules, including crawls of information and bugs over normal television programming (Coleman, Knupp, Spann, Elliott, & Peters, 2011). This way, the viewing public can make informed decisions and take action or not take action and still enjoy whatever it is they are watching. When a tornado is spotted and/or causing damage in a given viewing area, most television stations today will cut in to normal programming and provide wall-to-wall coverage (Coleman, Knupp, Spann, Elliott, & Peters, 2011). One of the more impressive examples of this wall-to-wall coverage and coordination of tornado warning information, storm spotters, radar images, and live camera images of damaging tornadoes was James Spann’s eight hours of continuous live tornado coverage on April 27, 2011. April 27 was the third day in what would be a deadly four-day record tornado outbreak from April 25-28, 2011. Spann is the chief broadcast meteorologist for WBMA-TV Birmingham/Tuscaloosa, Alabama (hereafter referred to as ABC 33/40) (Flanagan, 2016). Alabama would be struck by 62 tornadoes in two waves, killing a staggering 252 people ("Historic Outbreak," 2019). The entire sequence of events is available on the ABC 33/40 YouTube channel in a continuous eight-hour-and-thirteen-minutes video stream ("April 27, 2011 Historic…," 2016). While this is an extreme example, many broadcast media outlets can tie boosts in ratings to their coverage of high-impact events. ABC 33/40's coverage and Spann's subsequent role in matching tornado victims in need with resources via Twitter have made the chief meteorologist something of a folk hero in the state of Alabama. The skillful use of tower cameras and live storm chase video was a 21st century version of the first storm spotters working as an organization, bringing ground truth to the tornado warning process and increasing the skill of tornado and severe local storm forecasters.

Doswell, Moller, and Brooks' (1999) research on IWS identifies three user groups (audiences) which use weather information in an IWS: "1) news media and private sector meteorologists, 2) emergency management officials and storm spotters, and 3) the general public" (p. 552). All of these groups have been identified previously as part of the US weather enterprise. The relationship between media outlets, according to Doswell, Moller, and Brooks (1999), is not always cordial and causes breakdowns sometimes in the dissemination and understanding of tornado warnings. One of the responses by the US weather enterprise to the competitive broadcast media landscape has been the inception and evolution of NOAA Weather Radio. Instead of relying solely on the use of broadcast media outlets in competition with each other and hotlines to emergency managers and storm spotters, the NWS created a network of government-operated weather radio stations which covered, when first established, 70% of the American population and, ultimately, nearly 100% of the population after 1994 (Coleman, Knupp, Spann, Elliott, & Peters, 2011). These radio stations broadcast weather forecasts and updates 24 hours a day, seven days a week, 365 days a year. However, their utility is significant during severe weather, when tone alerts for tornado, severe thunderstorm, or flash flood warnings activate alarm tones on the weather radio receivers to wake people up in their homes if they owned one of these receivers (Coleman, Knupp, Spann, Elliott, & Peters, 2011). This is the only direct contact any NWS office has with the American public (Doswell, Moller, & Brooks, 1999). It serves as a redundancy should any of the other coordinated activity between NWS WFOs, broadcast media, and emergency managers fail.

Finally, tornadoes, while potentially deadly and destructive, are still quite rare and occur in a relatively concentrated area. And while the science and skill of tornado forecasting has increased, the phenomenon is still somewhat unpredictable. The Storm Prediction Center (SPC) brings to bear the resources of scientists and powerful computing to determine up to eight days prior potential severe weather in any given area of the United States. By one or two days before a severe weather day, the SPC issues outlooks that provide scientific information about the atmospheric conditions which would be favorable for severe thunderstorms and/or tornadoes. Severe thunderstorm criteria include hail up to one inch in diameter, and/or thunderstorm winds of 58 miles per hour or greater, and/or a tornado ("SPC FAQ"). As these outlooks go from day eight to day one, the SPC will work with local WFOs to collaborate and coordinate on timelines and other information to make sure the event is covered well. The managers of the WFOs can add extra staff and make sure other needs are met while threatening weather unfolds (Doswell, Moller, & Brooks, 1999). At day one (the day of), when severe weather outlooks are at their most refined, the next step for the SPC is to issue severe thunderstorm and tornado watches in coordination with multiple WFOs. This clues both the public and emergency management in to the possibility of severe weather in their area. Watches cover approximately 25,000 square kilometers (10,000 square miles) and may cover multiple states ("SPC FAQ"; Doswell, Moller, and Brooks, 1999). The SPC does not issue warnings. Warnings are issued by the local WFOs ("SPC FAQ"; Doswell, Moller, and Brooks, 1999).

Weather warnings, especially for severe thunderstorms and tornadoes, are time-sensitive and the information provided in the warning messages is "perishable" (Doswell, Moller, & Brooks, 1999). SKYWARN storm spotters are deployed during watches and warnings by local emergency management to serve two very important purposes. First, if they observe severe weather events after being deployed during a watch, they can report back to emergency management officials and the WFO so that a warning can be issued (Doswell, Moller, & Brooks, 1999). Second, emergency managers can deploy spotters as a result of severe weather warnings and provide important verification of severe weather through observation and communication back to WFOs and emergency managers (Doswell, Moller, & Brooks). The broadcast media can deliver messages to the public through the aforementioned methods. With the advent of smart phones and other wireless devices, alerts can be sent directly to the phones of people in warned areas based on either GPS locators in the smart phones themselves or based on proximity to a given television viewing area where stations can send alerts to subscriber phones (Coleman, Knupp, Spann, Elliott, & Peters, 2011). Some emergency managers also can directly call landline or cellular telephones in a warned area if the people who own the phones subscribe to such a service (Coleman, Knupp, Spann, Elliott, & Peters, 2011).

Where activity coordination presumes self-structuring, the nearly continuous and time-sensitive nature of the US weather enterprise's daily work may indicate that self-structuring presumes activity coordination. It is difficult to think of the activities of daily weather prediction, observation, and analysis without thinking of the organization of organizations coordinating their activities in such a way that they may structure themselves into a more accurate, more skillful, and more reliable set of organizations. Any organization in the US weather enterprise already identified (the WPC, the SPC, the trade organizations, SKYWARN spotters) operates in an ecosystem of activities and time-sensitive information with a preoccupation for accuracy both in the near- and long-term. Accuracy and uncertainty reduction are only as good as the ground truth, which is provided through communicative and constitutive activity. "The focal organization must actually connect with and induce return communication with important elements of its environment, and vice versa. It must establish or negotiate an image as a viable relational partner…" (McPhee & Zaug, 2000, p. 11). In this case, the US weather enterprise must position itself as a scientific institution, with member organizations positioning themselves simultaneously as being accurate and timely with their work product. Institutional positioning, the "communication between an organization and external entities" (Griffin, Ledbetter, & Sparks, 2015) and the fourth flow, will be considered. As an organization of organizations, or an institution comprised of institutions, the US weather enterprise's institutional positioning from within and outside the enterprise will illuminate the nascent role of the US weather enterprise as an engine for thoughtful economic development activity. Further, the role of the growing private weather industry as an entry point for institutional positioning will be examined.

Institutional positioning

Figure 1: This graphic represents how the US weather enterprise is viewed by the National Weather Service. Note the NWS sits in the middle and also beneath the surface. Adapted from National Weather Service (2018) article "The Weather Enterprise" and retrieved from https://www.weather.gov/about/weather-enterprise.

When considering the weather enterprise in the United States, it is difficult to ignore the NWS' sense of its own primacy in the constituted world of weather analysis, forecasting, warning, and observing. By far, most activity in which the NWS engages occurs in centers and offices across the country. The above graphic would lead someone outside the enterprise to believe that the NWS relies on partners in the media, their own NOAA Weather Radio stations, and private weather companies to assist in the delivery of timely forecasts and information to the public (see Figure 1). In this sense, the NWS is positioning itself as being primarily behind the scenes or “under the surface” of the US weather enterprise. One could even argue if not for the NWS, there would be no weather enterprise. The above graphic is important in considering how the NWS positions itself in the broader enterprise. However, any and all products produced by the NWS and its centers and WFOs is also available for free to users anywhere through their various internet sites.

Mass (2006) calls for increased coordination of all three sectors of the US weather enterprise: private sector, government, and academic research communities, with the understanding that “increasing overlap between sectors of the weather prediction community can represent a very healthy development, promoting creativity and cross-fertilization” (p. 574). Further, Mass (2006) problematizes US weather research and prediction as stemming from conflicts between the NWS and its array of laboratories, centers, and forecast offices, and the private weather industry. Additionally, Mass (2006) suggests the growing broadcast media part of the weather enterprise has lost touch with its audience’s needs. Indeed, the evolution of technology and increased understanding of the science of meteorology have contributed to the growth of both the US private weather industry, especially the robust broadcast media sources for weather information. However, because this growth has been somewhat unchecked, individual members of the US weather enterprise have decried the lack of leadership in the enterprise writ large.

In the intervening years since the Mass article’s appearance in the *Bulletin of the American Meteorological Society,* the US weather enterprise has evolved into a more coordinated institution of institutions. McPhee and Zaug (2000) suggest that any message can satisfy multiple flows. One could easily argue that activities stemming from calls to coordinate would naturally be a part of the activity coordination flow, but the messaging regarding coordination of the sectors of the enterprise acknowledges the privilege or lack thereof of any one sectoral or institutional position. Clearly, the NWS has and always will consider itself central to the US weather enterprise. It defines the US weather enterprise for consumer understanding. It identifies partners in its attempts to disseminate information to a consumer audience. Finally, on its own, the NWS has made a determined effort to help grow such partners into viable collaborators on all things weather.

Such collaborations between sectors has opened the door for the private weather industry to realize a greater partnership stake in the US weather enterprise. A 2017 report, generated by the NWS, analyzed the role of the private weather industry in the US weather enterprise (NWS, 2017). As the mission of the NWS has evolved to include "enhancement of the national economy" (NWS, 2017, p. 2), this analysis was deemed necessary for the US weather enterprise to understand the financial scope of the private weather industry and to help the NWS shape the narrative surrounding the growth of the US weather enterprise as an economic force. Such positioning activity situates the US weather enterprise in the role of partner to business and commercial interests where high-impact weather events and climate concerns intersect with the impacts of weather-dependent business operations. Private weather industry operations serve as an entry point for business and commercial interests into the US weather enterprise and, significantly, an entry point for the US weather enterprise into the business world. The conceptualization of the US weather enterprise's activities in the NWS as the "value chain" (NWS, 2017, p. 3) indicates a reimagining of the scientific processes involved in observing, monitoring, forecasting, modeling, warning, and disseminating/delivering as scalable business activity. By altering the communication surrounding how the US weather enterprise, and the NWS in particular, arranges its activities, other institutions can align their interests more readily with the weather enterprise.

Private sector growth in the US weather enterprise has been taking place since the postwar expansion years (AMS, 2012). With so many meteorologists being committed to the war effort during World War II, many struggled to find work when they were decommissioned. At the same time, the US Weather Bureau determined that all data it collected should be made public. Private companies were started to aggregate and deliver such data to the public. In this sense, the USWB (and then the NWS) were largely responsible for the data delivered to the public through the private sector. Much of the private sector does not have to concern itself with the limitations of the Federal Communications Commission's public interest standard and can leverage its resources to other private entities who are becoming increasingly reliant on sophisticated weather data and instrumentation (AMS, 2012). The private sector weather industry is growing into the driver of technical advances across the entire weather enterprise, which benefits both the public sector and the private sector of the American free market system. Nearly 3% of gross domestic product variability can be attributed to weather and climate (AMS, 2012). Thus, the institutional positioning within the US weather enterprise can be characterized by internal affordances being made by organizations to permit the private weather industry to become an unfettered innovator of weather data collection, measurement, and dissemination. Externally, the US weather enterprise is evolving into a partner for a broad array of US economic interests, which are already or may become susceptible to high-impact weather events and climate variability.

Discussion

Considering the United States weather enterprise, and considering McPhee and Zaug's (2000) conceptualization of the communicative constitution of organizations (CCO) in the four flows, one cannot ignore the singular element that forces the entire weather enterprise into what it is: the weather. The weather, as it is experienced, predicted, forecasted, reported, and analyzed, serves as a constitutive force which makes not only the US weather enterprise possible, but also makes it an "organization…grounded in action" (Putnam & Nicotera, 2010, p. 159). The weather forces the enterprise to engage in all four flows simultaneously and continuously. Unlike the seemingly finite nature of organizations engaging in communicative activity at various points in the process of those experiencing the organization, the US weather enterprise represents a perpetual state of engagement in the four flows in reflexive, reactive, and proactive constitutive practices. Since the weather never really stops, the weather enterprise must continuously produce its products and services in order to be a responsive organization of organizations with specific audiences in mind. Further, most of the products produced by the enterprise are time-sensitive or ephemeral, where expiration or closure occurs with the next forecast, prediction, analysis, or summary report. Member organizations of the weather enterprise negotiate themselves into it through activity coordination, which creates self-structuring opportunities. These opportunities create, through communicative activity, the organization of organizations which relate internally and externally at any given time to respond to any given weather situation.

The National Weather Service (NWS) produces several types of artifacts at various stages of the weather value chain, which are used by other sectors of the US weather enterprise. The NWS' role is significant. In some instances, the NWS is chief negotiator of members, not unlike the membership chair of a fraternity, sorority, or other social organization. It positions itself as it sees fit, naming partners and identifying where its offices and centers fit into the broader cycle of forecasting, predicting, warning, and disseminating. The weather enterprise, it would seem, cannot function without the NWS. However, the private weather industry can innovate and deliver its own services. In fact, it is *because* of the four flows and CCO that the private weather industry has a greater stake in the increased technology and innovation which has characterized the US weather enterprise since it was first considered. Significantly, gaining a seat at the table in the various trade and professional organizations, as well as creating its own representative organizations, sets the private weather industry on an intersecting path with the NWS and its centers and offices. With limited oversight and without the need to lobby for appropriations from the federal government year over year, the private weather industry is indeed poised to assume greater presence within the enterprise, especially through paid weather services companies and the increasing sophistication of the broadcast media sector. Simultaneously, the private weather industry, through the American Weather and Climate Industry Association's (AWCIA) efforts, has served as a lobbying agent for broader National Oceanic and Atmospheric Association (NOAA) financial support in the United States Congress. Its interests are twofold and obvious. First, increased funding of NOAA and agencies underneath it (including the NWS) means increased research and development opportunities to better and more fully understand weather and predict it more effectively. Second, the private weather industry can serve as a partner in these efforts in both name and function through its deployment of innovative technologies and its other self-structured functions in the US weather enterprise.

It would be simplistic and reductive to call the US weather enterprise a public/private partnership, even though sectors are both public and private. However, CCO-as-perspective and the four flows help us to understand a way in which relationships among organizations and institutions work. Another area of application for CCO and the four flows is the nascent collaboration of the National Aeronautics and Space Administration (NASA) and the private space exploration company, SpaceX. NASA's existence can be traced to 1958, where an act of the United States Congress established the administration of space-related exploration and problems of both inter-atmospheric and extra-atmospheric flight. The ramp-up of the Cold War and the race to explore space with the United States' chief rival in said war, the Soviet Union (Garber & Launius, n.d.) were the forces that brought NASA into being. As the exploration of space and the landing of men on the moon became the primary activities NASA was known for, their use of launch vehicles funded solely by the government and constructed from parts contracted out to commercial entities became difficult to sustain over time. Funding shifts also meant the end of the Space Shuttle program among others, while commercial companies and other government agencies (such as NOAA) started launching satellites with regularity. Enter SpaceX.

SpaceX, founded by Elon Musk in 2002, develops rockets and other delivery vehicles to explore space and assist governments with such goals. They are a private company ("Company," 2012) which has delivered to the International Space Station and deployed both government-funded and private satellites into space. Their vehicles are capable of returning to their launch sites unmanned as well as docking autonomously to the International Space Station ("Company," 2012). NASA and SpaceX successfully rendezvoused the SpaceX Dragon rocket to the International Space Station in 2012, delivering among other things 15 student projects as a part of the Student Space Flight Experiments Program (SSEP) (Dunbar, 2015). The projects, collectively known as Aquarius, represent a partnership between the National Center for Earth and Space Science Education and NanoRocks, LLC, a national science, technology, engineering, and math (STEM) initiative (Dunbar, 2015). This successful launch has been followed by nearly 100 more ("Company," 2012), and represents a successful partnership among the government-funded scientific community, academia, and the private sector. This is a very similar model to the US weather enterprise, where CCO and the four flows model are applicable to these ventures. Member organizations are called into being by a major government agency, which ascribes various roles to such organizations. Self-structuring takes place as the various parts of this space enterprise become part of the pre-launch, launch, and rendezvous activity. Activity coordination takes place on a continuum among all three of the sectors to deliver supplies and student-led projects to the International Space Station on commercial spacecraft, and such companies can position themselves to become the chief innovators in partnership with other organizations within a broad space enterprise.

Such enterprise arrangements (coalitions or collaborations of institutions behaving like members of an organization or institution) have been notable especially in the beginning of the 21st century. The US weather enterprise and the NASA/SpaceX collaboration represent new understandings of what constitutes organizations. While many of the member organizations are hierarchical in nature, the four flows and CCO eschew hierarchy in favor of communicative practices that establish the organization as a process through action. Organizations of organizations can freely arrange themselves into enterprises for the sake of innovation, problem solving, and/or some external force that naturally brings such groupings together. These enterprises have borne witness to incredible strides in technology and epistemological understanding of natural phenomena, have been able to share in this richness of understanding with various interested publics, and have both synergized and subordinated member organizations as the four flows continue to work through them. This is perhaps the best legacy of CCO and the four flows—the potential for this conceptualization of organizing to solve the great problems and answer the pressing questions of 21st-century society. By the beginning of the 22nd century, the landscape of organizational communication and, significantly, innovation across disciplines, nations, and divides will look very similar to the US weather enterprise of today: an institution of institutions grounded in practical communicative theory.

Limitations

There is an incredible volume of information about the US weather enterprise available for consumption. The National Weather Service (NWS), in another thesis, could be considered a byzantine bureaucracy suspended in other byzantine bureaucracies. The publicly available, free access organizing artifacts of the NWS are significant. Similarly, research articles in the disciplines of atmospheric science, meteorology, and broadcast meteorology are quite numerous. However, the same cannot be said for articles within the communication studies discipline, and organizational communication in particular. One cannot model an argument regarding the structure or the communicative life of the US weather enterprise, or one or more of its sectors, with extant research within our field. That is not to say that social scientific research has not been brought to bear on the US weather enterprise, especially in regards to public responses and reactions to high-impact weather events. The communication perspective, outside of the transmission model or *tele*communication*s*, is altogether missing from practical theoretical approaches to the US weather enterprise.

Further, much of the work of all three sectors of the US weather enterprise (government-funded, academia, and private weather industry) centers on the NWS and its offices and centers as leaders in the enterprise. Individual members of the enterprise, representing one or more sectors of the enterprise, write and publish articles and other forms of research for other members within the enterprise. In this case, two-thirds of the enterprise is represented by the government-funded agencies and centers under the NOAA umbrella, as well as academia. Academia's responsibility is to provide avenues for further research to expand the enterprise's understanding of meteorological phenomena while also preparing future atmospheric scientists and meteorologists who will go to work for either the government or the private weather industry. This insularity makes it difficult to approach the US weather enterprise from outside the field. Further, the NWS' changing attitude towards the private weather industry has not provided the whole enterprise with a true understanding of its importance. Only in the past few years has the NWS sought to recognize the importance of the private weather industry. Tensions between the private and the public reached their boiling point in 2004 with the Commercial Weather Services Association (CWSA, which evolved into the AWCIA) and 2005 with the repeal of a 1991 non-duplication and non-competition policy between the private weather industry and the NWS (Mass, 2006). Rick Santorum, the then-Republican senator from Pennsylvania, introduced this legislation, backed by the CWSA (Mass, 2006). Not insignificant in this battle is the fact that Santorum's home state of Pennsylvania is also the headquarters of AccuWeather, one of the two largest private weather companies in the country and active participant in the CWSA. If two thirds of the weather enterprise (academia and government-funded) are collaborating on research and preparing future scientists, then of course the NWS could become a subordinating force that prevents collaborations with the private sector based on the ill will associated with the low point in relations. This also becomes a corroding thread in the research that is generated within the US weather enterprise. Only recently, with the increased and improved innovation coming from the private weather industry, has the NWS and its centers and offices realized the importance of the private weather industry as a partner.

Future Research

As we ground theoretical approaches such as CCO through reflexive and reflective practice, applications and extensions of theory will create multiple entry points to understand how and why organizing takes place as a process grounded in action. How the US weather enterprise organizes through CCO and the four flows should evolve into applied research as to how the US weather enterprise performs. Social scientific research in other fields (i.e. sociology, psychology, geography, and anthropology) has delved into the public's response to warnings and other messages from various parts of the US weather enterprise. However, from the communication perspective, Weick and Sutcliffe's (2015) FSORE model of high-reliability organizing (HRO) is a means of learning how the weather enterprise performs given the enormous complexity of the institutions housed in the enterprise. Their model frames organizing as a mindful practice and a dynamic process, instead of framing organization as a "static container" (Weick & Sutcliffe, 2015, p. 35). The FSORE model establishes five practices of mindful organizing: preoccupation with Failure, reluctance to Simplify, sensitivity to Operations, commitment to Resilience, and deference to Expertise (Weick & Sutcliffe, 2015).

The management of uncertainty has long been a part of the art of weather forecasting. Coping with the unexpected was the hallmark of public response to weather events before the broad dissemination of weather forecast information was inscribed into the US weather enterprise as an institution. A common attitude of the public regarding weather forecasting, especially in broadcast meteorology, is that forecasts are wrong much of the time. Such unscientific characterizations of weather forecasts may or may not be harmful to the US weather enterprise, but what counts as a wrong forecast versus a forecast that is close to being exactly correct is as variable as the weather itself. FSORE could help the enterprise learn what counts as failure and how to remedy failures in the system. The model can also bring multiple sources of information forward to create better, more complex forecasts that get closer to being correct. Operationally, continuous analysis of how the sectors individually and as a whole work together, with sensitivity to the results of such analyses, may increase optimization of the performance of the entire weather enterprise. Such optimization may build resilience into a system that already, through the four flows, has redundancies in place so that no one part of the enterprise, or more importantly, the public, is left out of the process of understanding risks and managing against the unexpected. Finally, deferring to the expertise in the enterprise has already legitimated the private weather industry as a partner of, and, most importantly, a sector of the US weather enterprise. This is especially true in regards to increased technological innovation in forecasting, dissemination, and measurement. Because the US weather enterprise is an organization grounded in action, there are multiple entry points into our common understanding of how it actually works. Weick and Sutcliffe's (2015) mindful organization model is an elegant way to understand how the US weather enterprise could be regarded as a high-reliability organization.

The US weather enterprise-as-organization demonstrates the calling forward of other organizations to become a part of the enterprise through all four flows. One sector mentioned, but not heavily covered, in this thesis is the emergency management and incident command structure. Obviously fair weather or benign hazards like light rain do not require the full force of emergency management or a robust incident command structure. However, high-impact meteorological events such as wildfires, hurricanes, tornadoes, flash floods, blizzards, and ice storms do require elements of emergency management to help keep the public and their assets out of harm's way if possible. Applying McPhee and Zaug's (2000) four flows model to the incident command structure may provide a parallel understanding of the organization of police, fire, rescue, military, and utility companies into a legitimate enterprise within a finite period of time. Manmade disasters, such as plane crashes, building collapses, and terrorist attacks, have forced the hand of emergency management officials to create an incident command system (ICS) (Bigley & Roberts, 2001). This is a form of high-reliability organizing in an adaptive form. The four flows model and CCO are another way of understanding how ICS works. In this way, the constitutive force of a high-impact weather event of unknown duration imposes an ICS, which behaves as an organization of organizations. Here, too, the US weather enterprise can call emergency management a partner, and vice versa. Due to increased skill in long-term forecasting, the US weather enterprise can prepare emergency management to enable the ICS as early as four to seven days prior to an anticipated event.

Conclusion

Characterizing the US weather enterprise critically as an “uncoordinated giant” (Mass, 2006) or an “orchestra without a conductor” (Pielke & Carbone, 2002) were unique ways to problematize the lack of constitutive and coordinated action between sectors of this large, amorphous grouping of organizations. However, the considerations of these authors as to how to make the US weather enterprise function more cohesively are part of a series of actions taken by all three sectors of the enterprise to communicate it into being. The US weather enterprise is an organization communicatively constituted by its three sectors: the US private weather industry, the federally-funded public sector, and academia. Applying communicative constitution of organizations and the four flows model (McPhee and Zaug, 2000) in particular to the US weather enterprise distinguishes the enterprise as an organization of organizations. In this way, as Putnam and Nicotera (2010) suggest, the US weather enterprise encompasses all three understandings of organization: organization as entity, organization as process, and organization as grounded in action. Through membership negotiation, reflexive self-structuring, activity coordination, and institutional positioning, the US weather enterprise behaves as an organization of organizations. No conductor is needed, and while giant, it exhibits remarkable coordination when forced to by the weather itself. While portions of the enterprise may try to center themselves and cast the rest of the enterprise as a universe revolving around them, the enterprise as an institution of institutions democratizes the entire endeavor as partners among partners, members among other members, and forced into being by the next forecast or major weather event.

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Curriculum Vitae

Matthew Carter Rothrock

Education

Master of Arts	Applied Communication Studies
Indiana University	Awarded at Indianapolis (IUPUI)
October 2019	

Bachelor of Arts, High Distinction	English Language and Literature
Indiana University	Awarded at Indianapolis (IUPUI)
December 2008	

Training Experience and Employment

- Speech Coach, Columbus East High School, 2007-present
    - Treasurer, Indiana High School Forensic Association, 2017-present
    - At-Large Board Member, Indiana High School Forensic Association, 2015-present
- Student Success Coordinator, Indiana University-Purdue University Columbus, 2017-present (previously Academic Resource Center coordinator, 2011-2017)

Conferences Attended

- Central States Communication Association
    - 2016, 2017, 2019

    - Presenter: "A Semiotic Analysis of WeatherBrains Episode 606: Unshaven in My Gym Shorts," 2019, Omaha, NE.
- Nineteenth Annual International Student Conference: Communication and Culture, May 23-24, 2018, Wroclaw, Poland
    - Presenter: "A Semiotic Analysis of WeatherBrains Episode 606: Unshaven in My Gym Shorts"