(1) Statement of the research problem: The 2020 hurricane season has been forecasted to be "an extremely active hurricane season" by numerous forecasting groups (e.g. Colorado State University (CSU), NOAA, and Tropical Storm Risk (TSR)). As of the August 5 (2020) forecast by the Colorado State University, the number of named storms is forecasted at 24, the number of hurricanes at 12, and the number of major hurricanes at 5, with an accumulated cyclone energy index of 200 (all these numbers are approximately double the 1981-2020 averages). This is a result of sea surface temperatures averaged across the tropical Atlantic being considerably warmer than normal and vertical wind shear much lower than average. It is expected that the cool neutral ENSO conditions observed during the first part of the hurricane season may transition to weak La Niña conditions. The CSU team anticipates "an above-normal probability for major hurricanes making landfall along the continental United States coastline and in the Caribbean" (Klotzbach et al. 2020).

This expected activity is compounded by the fact that we are in a global pandemic. SARS-CoV-2 (COVID-19) has, since December 1, 2019, spread to all the world's 198 countries except 10 Pacific Island nations. COVID-19 has caused 858,629 deaths as of September 3, 2020 (World Health Organization [WHO] 2020). It is the fifth pandemic to affect the world since the 1918 H1N1 influenza pandemic, known as Spanish influenza (Center for Disease Control and Prevention [CDC], 2018). The February 1918 to April 1920 pandemic infected ~500 million and killed between 17-50 million, the 1957-1958 H2N2 influenza infected in-excess of 100 million and killed ~1.1 million, the 1968 H3N2 influenza killed 1 million, and the 2009 H1N1 influenza killed in-excess of 201,000 (Barro et al. 2020; Kilbourne 2006; Simonsen et al. 2013). Furthermore, the largest hurricane evacuation in U.S. history (Bousquet and Klas 2017) occurred in the recent 2017 season with Hurricane Irma making landfall in the state of Florida as a Category 4 hurricane on September 10, 2017. Hurricane Irma had a death toll of 129 people and had a total cost of $50 billion. Around 6 million Floridians evacuated their homes for Hurricane Irma and, in the Keys, approximately 75% of the residents evacuated (Cangialosi et al. 2018). There were 77,000 people in 450 shelters (Amadeo 2020) and 54 out of 67 counties in Florida issued evacuation orders (Turner 2018). Should such a forecasted hurricane occur in this extremely active 2020 season, residents will be making complex decisions as they balance their need to evacuate and the risk of COVID-19 infection. As we have already seen with Hurricane Laura (8/27/20) making landfall as a Category 4 (the strongest hurricane to hit Louisiana in over a century), this was the first time in our history when a mass evacuation was warranted during a pandemic.

While guidance from hurricane experts reminds residents that they should prepare the same for every season, regardless of how much activity is predicted, the 2020 season is different due to the COVID-19 pandemic and is causing individuals to re-think their evacuation plans. COVID-19 (declared as a pandemic by the World Health Organization on March 11, 2020) has resulted to date (September 3, 2020) in 6.11 million cases and 184,000 deaths in the United States (WHO, 2020). It is plausible that a large evacuation, which encourages movement and large gatherings, may trigger a sharp uptick in COVID-19 cases and deaths, exacting a higher death toll than hurricanes alone. The pandemic increases the complexity of planning for hurricanes as social distancing is in direct conflict with human mobility and congregation.

These compounding risks posed urgent challenges for those in the path of Hurricane Laura that made landfall as a Category 4 hurricane along the Gulf Coast. The evacuation from Hurricane Laura resulted in not only hurricane related casualties but also a potential surge in COVID-19 cases and deaths. Given that social distancing is warranted, and there are capacity issues at public shelters, there may have been competing priorities when deciding to evacuate. As a result, people may have risked sheltering in place to avoid COVID-19 exposure despite being in an evacuation zone or structure that does not meet current building code standards to withstand a major hurricane. Public hurricane shelters tend to be utilized by the most vulnerable, those who lack the economic means for other evacuation options, and populations with underlying health conditions that place them at higher risk for COVID-19 complications. One of the most vulnerable populations in terms of evacuating for weather-related disasters is older people and based on the statistical analyses conducted by Collins et al. (2020), the older population is especially vulnerable during the 2020 hurricane season. On top of the decreasing physical and cognitive abilities that are a characteristic of aging, around 80% of adults aged 65 years and older have a chronic health condition that make evacuating more complicated than for younger populations (Aldrich & Benson 2008). These pre-existing conditions can also make older people more susceptible to other illnesses and viruses, so hurricanes pose an even bigger threat to their health because they increase the spread of pathogenic diseases (Maness 2019).

In June 2020, an online survey (in both English and Spanish) of 40 questions was disseminated to Florida residents through regional planning councils, emergency management, and the media. 7,102 people, from over 50 counties, responded in just over two weeks. This research has been submitted to the Bulletin of the American Meteorological Society (Collins et al. 2020) after the proposal was approved. Collins et al. (2020) found that half of the respondents view themselves as vulnerable to COVID-19 due to their health status. 74.3% of individuals viewed the risk of being in a shelter during the COVID-19 pandemic as more dangerous than enduring hurricane hazards. Additionally, there was a significant number of individuals who would choose to not utilize a public shelter during COVID-19 when they would have previously. Hurricane Laura (and likely future 2020 landfalls) provide a unique and necessary opportunity to examine people's actual evacuation behavior and risk perception. The purpose of this research is to understand public perceptions of the compounding risks of COVID-19 and hurricane-induced storm surge, as well as other hurricane aspects affecting evacuation decisions, ultimately examining the extent to which people risk their lives by sheltering in place rather than evacuating. The research questions addressed in this research include: How will COVID-19 (and its associated health vulnerabilities) affect people's risk perceptions and evacuation decisions? Do people view public shelters as overtly risky and will instead choose to shelter in place despite a mandatory evacuation order due to concerns over COVID-19? Prior research has not been conducted into an individual's risk perception of natural hazards as they consider evacuating from a hurricane during a pandemic; COVID-19 poses a unique threat with shelter management considerations far beyond other cases of infectious diseases during hurricane evacuations. Officials also need to understand how evacuation plans change with COVID-19 encouraged social distancing, which is in direct conflict with the movement and congregation seen in hurricane evacuations.

(2) Intellectual Merit: While research relating to hurricane evacuation behavior and perceptions of the risk has grown throughout the years (Baker 1979, 1991, 1995; Brinkley 2006; Buckle 2006; Collins et al., 2017, 2018; Dash and Gladwin 2007; Demuth et al. 2012; Dow and Cutter 1998, 2000; Dynes 2002; Eisenman et al. 2007; Elder et al. 2007; Gladwin et al. 2001; Haines et al. 2002; Miller 2007; Moore et al. 2004; Morss et al. 2016; Riad and Norris 1998; Senkbeil et al.

2019; Sherman-Morris et al. 2011; Whitehead et al. 2000), there is very little understanding of how COVID-19 will impact people's evacuation decisions. COVID-19 (SARS-CoV-2) has, since December 1, 2019, spread around the world with 25.1 million cases and over 843,000 deaths as of September 2020 (John Hopkins University, 2020). In fact, SARS-CoV-2 is comparable to both the 1957 Asian flu that killed in-excess of 1.1 million people and the 1968 Hong Kong flu that killed 1 million people (Barro et al. 2020; Kilbourne 2006; Simonsen et al. 2013). Understandably, much of the U.S. population has no prior experience planning for hurricane evacuations during a pandemic. Research though indicates what we should expect.

To determine the nature of disease outbreaks after natural disasters, Bissell (1983) found that hurricanes lend themselves to increasing the spread of disease by forcing large numbers of people into situations that are especially conducive to the spread of disease via respiratory droplets. Likewise, Lemonick (2011) conducted a study of past natural disasters and their associated diseases and found that crowding increased disease transmission, a frequent concern in shelters. Ivers & Ryan (2006) found that after a natural disaster "the congregating of displaced individuals" increased disease transmission. In another analysis of how tropical cyclones impact disease spread, Shultz et al. (2005) conducted a study on a wide variety of hurricanes and their associated disease outbreaks. They identified six factors which can play into infectious disease outbreaks: 1) disruption of public health services and the health-care infrastructure, 2) damage to water and sanitation networks, 3) changes in population density (especially in crowded shelters), 4) population displacement and migration, 5) increased environmental exposure due to damage to dwellings, and 6) ecologic changes. They note that infectious disease outbreaks after hurricanes are almost unheard of in developed countries. However, COVID-19 has brought about unprecedented public health challenges to coastal areas in the United States that require a new approach to planning during the 2020 hurricane season from both emergency managers and the public.

Shukla et al. (2018) suggested that the 1,000 evacuees infected during a Norovirus outbreak among Hurricane Katrina evacuees in a "mega shelter" was due to overcrowding, resource limitations, and reduced hygiene. Their investigation found that although intensive public health measures were promptly instituted, the progression of the outbreak of norovirus was not slowed. Yee et al. (2007) and Murray et al. (2009) also determined that the illness spread through person-to-person transmission, contact with contaminated surfaced, and large aerosolized vomitus droplets. In contrast, a Hurricane Harvey "mega shelter" in Harris County, Texas, which housed 3,365 residents at its peak, had an Influenza A outbreak. Liu et al. (2019) noted that the rigorous approach of emphasized handwashing, enhanced inspection and cleaning, isolation of ill individuals, and on-site vaccinations helped limit the outbreak to just 20 cases.

Travers (2020) captured the underlying psychological variables that might explain differences in attitudes toward COVID-19. He found that Americans generally fall into one of five "types" when it comes to their attitudes regarding COVID-19. Those were labelled as: (1) "Sounding-all-alarms," (2) "At-risk," (3) "Under-control," (4) "Open-ups," and (5) "Dismissers". Group 1, which was the largest group (29%), feel that the federal response has fallen short and worry about things getting worse, whereas group 5, the joint smallest group with group 4, think the concern has been blown way out of control. Group 1 are younger, more likely to live in urban areas, and more likely to be members of a minority group. Various studies support the conclusion that racial and ethnic minority populations are at greater risk during pandemics because they often have less capacity to implement preparedness strategies or tolerate its impact given disparities in

underlying health status and social factors, such as socio-economic disadvantages, cultural, educational and linguistic barriers, and lack of access to health care (Hutchins et al. 2009).

With Hurricane Laura, residents made complex decisions as they balanced their need to evacuate against the risk of contracting COVID-19. This study will be one of the first to capture data that contributes to new literature on COVID-19 and risk perceptions during actual major hurricanes, starting with data to be collected from those impacted by Hurricane Laura. This study will benefit emergency planners with communicating risk and targeted messaging along with adding to the body of knowledge.

3) Broader Impacts: COVID-19 poses a unique threat with shelter management and mass care in comparison to other infectious diseases during prior hurricane evacuations. Emergency managers and public health planners - including federal officials, private sector, and nonprofit organizations - need to understand how hurricane evacuation plans change with COVID-19 to analyze various scenarios and evaluate existing strategies. This study will help anticipate crucial resources, need for mutual aid agreements, and reveal improvements for public messaging that will ultimately save lives. Formative research supports social marketing and public health interventions designed to educate and support behavior change regarding evacuations.

(4) Need for urgency: Memory decay can contribute to differing perceptions and recollections of past events, and this can be limiting in seasonal evacuation research (Stallings 2002). There is the potential for perceptions and thoughts to become altered over time (Baker 1979; Baker 1991; Lindell et al. 2005). There is also an acute urgency to understand the impact of COVID-19 risk perceptions and the extent to which people risk their lives by sheltering in place rather than evacuating during threatening tropical cyclones. Prior research suggests that without good planning there is an increased risk of compounding impacts originating from natural hazard events during the COVID-19 pandemic (Quigley et al. 2020). Officials can use the results of this study to better inform planners of how to prepare the shelters and mitigate health risks from COVID-19. It is therefore critical that the survey be disseminated in a timely manner, as soon after Hurricane Laura (and other hurricanes that trigger large-scale evacuations) as possible. With the 2020 hurricane season forecast to be approximately twice the activity compared to average, it is likely we will also be able to deploy this survey for other hurricanes, particularly in Florida, and will allow researchers to rapidly disseminate the survey to an affected community. Preliminary results will be made available to stakeholders in the affected area at our earliest availability which will assist them with preparedness and resource allocation through the remainder of the 2020 season (which is likely to extend past the official end date), and help planners for future seasons where we have a confluence of crisis between hurricane evacuations and a pandemic. RAPID is the most appropriate mechanism for this award as it calls for projects with an urgent need to collect data on disasters.

(5) Methods: An anonymous survey in both Spanish and English will be administered online hosted through Qualtrics and distributed to residents who were in the path of some 2020 hurricanes inc. Hurricane Laura. Our network of distribution consists of regional partnerships with National Weather Service, Emergency Management, and media. The primary means of recruitment will be through email and social media by our stakeholders. The survey instrument will contain 40 questions, offered in both Spanish and English, and will collect information regarding risk perception with evacuation and public sheltering. The survey instrument will include questions on demographics, characteristics of their home (such as evacuation zone, year built, and structure), special needs shelter use, and pre-existing health conditions. The survey will also include a variety

of Likert-scale questions that are aimed at assessing an individual's perception of risk regarding sheltering-in-place versus going to a public shelter.

6) Data Expected: The expected data will consist primarily of categorical and ordinal data that can be analyzed using nonparametric testing, such as chi-square tests, McNemar's tests, and Spearman's rho. Data will entail results from the 40 questions, including additional string comments that are provided in the "other" description boxes within the survey. This primarily quantitative data set will represent categorical or ordinal answers, such as Likert-scale questions ranging from "definitely true" to "definitely false".

7) Proposed Analysis: After data are cleaned from their original Qualtrics output, analyses will be conducted using SPSS v.26. Figures and maps will be produced using ArcGIS Pro and MATLAB. As mentioned, due to the overwhelming majority of questions being either categorical or ordinal in nature, nonparametric testing (e.g. chi-square tests, McNemar's tests, and Spearman's rho) will be conducted.