IMPROVED TORNADO WARNING VIA ATMOSPHERIC MONITORING OF INFRASOUND

Introduction

On average over the past decade, tornadoes have caused over 1200 injuries and 110 fatalities per year (NOAA, 2015), with many of these injuries and fatalities occurring in the state of Oklahoma. The population in tornado prone areas is growing (Pew Research Center, 2008), which will lead to higher death rates without an improved warning system. Tornado warning improvements have reached a plateau, and minimal new improvements have been made since 2003 (Wurman et al., 2013). According to NOAA (2010), further advancement of warning systems will require new approaches of severe weather detection. A study done led by AJ Bedard (Bedard et al., 2004) shows that tornadoes emit an infrasonic noise hours before they touch the ground. This phenomenon can be broken down into four subtopics: how the tornadic flow produces sound, how the sound is altered as it propagates, how to measure the sound, and how to process the data. My research will focus on how the sound produced by a tornado changes as it travels through the atmosphere.

Background

Infrasonic sound can be emitted from various sources, such as earthquakes, propane torches, subwoofers, and others. This infrasonic signature acts as a pressure wave as it moves through the atmosphere. As the wave propagates, its characteristics are likely to change due to certain weather conditions (e.g. temperature, pressure, humidity, etc.). If this change in the acoustic signature of a tornado can be quantified, the signal can then be reconstructed to determine the original source from the signal captured by a microphone.

Objective

The purpose of this research is to develop a model for infrasonic attenuation and validate the model with experimental data.

Methodology

The first step is to develop a simple model that numerically estimates the change in an acoustic signal as it propagates through the atmosphere at a specific condition. This Computation Fluid Dynamics (CFD) model will be developed using analytical and empirical relationships. A few different scenarios will be run to determine how a signal changes depending on weather conditions. The next step will be to gather experimental data from measuring infrasonic signals in the atmosphere. One microphone will be by a speaker to measure the signal of that speaker. Another microphone will be set up some distance away to measure how the original signal changes. This data will be used to compare the original signal to the propagated signal to determine the affects of weather conditions. This test will be repeated for various weather conditions. After the test data has been analyzed, it will be compared to the results of the model. The model will replicate the weather conditions of each test; if the experimental values match that of the model values, then the model can be assumed accurate. The experiment will act as validation of the developed model.

Timeline

Task Name	Duration (days)
Task 1: Run experiments to become familiar with attenuation	14
Task 2: Develop model with reference data	21
Task 3: Conduct additional experiments at different atmospheric conditions	28
Task 4: Assess accuracy of model	14