

Forecasting Extreme Weather: When and Under What Atmospheric Conditions Are Tornadoes Likely to Develop in the Oklahoma City Area?

Introduction

A tornado is a violent rotating column of air that extends from the clouds to the ground. The wind speeds in a tornado can reach as high as 480 kilometers per hour (almost 300 miles per hour). A tornado can destroy large buildings, uproot trees, and hurl vehicles hundreds of yards. The Oklahoma City metropolitan area is one spot in the United States that is known for frequent tornadoes. According to the National Weather Service, at least 162 tornadoes have touched down in the Oklahoma City metropolitan area between 1890 and 2013, an average of just over one per year (National Weather Service 2017). An example of a tornado in this area was the one that hit Moore, Oklahoma, on May 20th, 2013 at 2:46 p.m. (CDT) (National Weather Service n.d.; Thompson 2013). It stayed on the ground for 47 minutes, traveled 22.5 km (14 miles), and was 1.7 km (1.1 miles) wide at its peak (see Figure L21.1). The 2013 Moore tornado killed 24 people, injured another 212, destroyed 1,150 homes, and caused \$2 billion in damage (see Figure L21.2).

FIGURE L21.1

The 2013 EF5 Moore tornado as it passed through south Oklahoma City



FIGURE L21.2

An overhead view of damage done by the 2013 Moore tornado



Tornadoes tend to develop within a supercell, which is a thunderstorm with a large rotating updraft. Thunderstorms tend to develop at locations where there is an interaction between a warm air mass and a cold air mass. Two air masses, however, can interact with each other in many different ways. For example, a warm air mass can move into an area that was formerly covered by cold air mass. A cold air mass can also move into an area that was occupied by a warm air mass. A warm air mass and a cold air mass can also move parallel to each other. These are just a few examples of how warm and cold air mass can interact with each other. Some of these interactions might lead to the development of a thunderstorm and some might not. Tornadoes also tend to develop in different regions during certain times of the year and at certain times of the day. People can make better forecasts about when tornadoes are likely to develop if they understand when tornadoes tend to happen and the atmospheric conditions that tend to be associated with them.

There are still many questions to be answered about what causes a tornado to develop and the factors that affect the wind speed of a tornado. One of the best ways to learn more about tornadoes is to keep a record of which months they happen, what time of day they happen, and what the atmospheric conditions are like in a region right before they develop and then look for patterns that might give us clues about when they are likely to develop and why. This information can then be used to help forecast future tornadoes and to inform the development of new technologies that can mitigate the damage that often results from this type of catastrophic event.

In this investigation, you will have an opportunity to use historical weather records to determine when tornadoes tend to occur in the Oklahoma City area and what the atmospheric conditions were like in the region at that time. You can then use this information to identify a way to help predict when a tornado will likely appear in or around Oklahoma City.

Your Task

Use what you know about natural hazards, weather, patterns, and cause-and-effect relationships to analyze historical weather data from the Oklahoma City area to determine when tornadoes tend to happen in this area and what the atmospheric conditions tend to be like at that time. Your goal is to help people in the Oklahoma City area make better forecasts about these potentially catastrophic events.

The guiding question of this investigation is: **When and under what atmospheric conditions are tornadoes likely to develop in the Oklahoma City area?**

Materials

You can use the following online resources during your investigation:

- The National Oceanic and Atmospheric Administration (NOAA) National Weather Service provides information about every recorded tornado in the Oklahoma City area at www.weather.gov/oun/tornadodata.
- NOAA Central Library's Daily Weather Map Archive provides historical U.S. weather maps at www.wpc.ncep.noaa.gov/dwm/dwm.shtml.
- Weather Underground provides historical weather data at <https://www.wunderground.com/history/>.

Getting Started

To answer the guiding question, you will need to analyze historical weather data. The first step in your analysis is to learn more about the tornadoes that have hit the Oklahoma City area. You will need to know when during the year these tornadoes developed, what time of the day they happened, how long they lasted, the path they followed, and their magnitude. NOAA provides this information about every recorded tornado in the Oklahoma City area since 1890. You can decide which ones and how many to study.

The next step in your investigation will be to learn more about what the atmospheric conditions were like in the Oklahoma City area before these different tornadoes developed. To accomplish this goal, you can use the NOAA Central Library's Daily Weather Map Archive or Weather Underground. The NOAA Central Library's Daily Weather Map Archive allows you to look up and download the weather maps for the entire United States for a specific date in the past. The Weather Underground website allows you to look up detailed information about the weather in any city dating back to 1945. You can use these two websites to investigate the changes in weather conditions near the dates of the tornadoes listed in the Oklahoma City Area Tornado Table. When you access these websites, you need to think about what data you need to collect, how you will collect it, and how you will analyze it.

To determine *what type of data you need to collect*, think about the following questions:

- Of all of the information you can access, which data are relevant and which data are irrelevant?
- How will you decide which tornadoes to include and which ones to exclude in your study?

To determine *how you will collect the data*, think about the following questions:

- How much data do you need to sufficiently answer your question?
- What scale or scales should you use?
- How will you keep track of and organize the data you collect?

To determine *how you will analyze the data*, think about the following questions:

- What types of patterns could you look for in your data?
- How could you use mathematics to describe a change over time?
- What type of table or chart could you create to help make sense of your data?
- How could you use mathematics to describe a relationship between variables?

Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question you were trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.