Lab Handout

Lab 21. 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 *www.wunderground.com/history.*

Safety Precautions

Follow all normal lab safety rules.

Investigation Proposal Required? ☐ Yes ☐ No

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?
- How will you organize your data?

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?

Connections to the Nature of Scientific Knowledge and Scientific Inquiry

As you work through your investigation, be sure to think about

- the difference between data and evidence in science, and
- how scientists use different methods to answer different types of questions.

Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The *claim* is your group's answer to the guiding question. The *evidence* is an analysis and interpretation of your data. Finally, the *justification* of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L21.3.

FIGURE L21.3

Argument presentation on a whiteboard

The Guiding Question:	
Our Claim:	
Our Evidence:	Our Justification of the Evidence:

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One or two members of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the other arguments. This is similar to what scientists do when they propose, support, evaluate, and refine new ideas during a poster session at a conference. If you are presenting your group's argument, your goal is to share your ideas and answer questions. You should also keep a record of the critiques and suggestions made by your classmates so you can use this feedback to make your initial argument stronger. You can keep track of specific critiques and suggestions for improvement that your classmates mention in the space provided.

Critiques of our initial argument and suggestions for improvement:

If you are critiquing your classmates' arguments, your goal is to look for mistakes in their arguments and offer suggestions for improvement so these mistakes can be fixed. You should look for ways to make your initial argument stronger by looking for things that the other groups did well. You can keep track of interesting ideas that you see and hear during the argumentation in the space below. You can also use this space to keep track of any questions that you will need to discuss with your team.

Interesting ideas from other groups or questions to take back to my group:

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the best argument possible.

Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections. Each section should provide an answer for the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in two pages or less. You should write your report using a word processing application (such as Word, Pages, or Google Docs), if possible, to make it easier for you to edit and revise it later. You should embed any diagrams, figures, or tables into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid.

References

National Weather Service. n.d. Moore, Oklahoma tornadoes (1890-present). *www.weather.gov/oun/tornadodata-city-ok-moore.*

National Weather Service. 2017. Tornadoes in the Oklahoma City, Oklahoma area since 1890. *www.weather.gov/oun/tornadodata-okc.*

Thompson, A. 2013. New satellite image shows Moore tornado scar. *www.livescience.com/37176-moore-tornado-damage-satellite-image.html.*