

Module 4, Lesson 1

Finding Tornado Alley

Lesson overview

Students will work with 10 years of tornado data for the entire United States to locate Tornado Alley. Furthermore, they will use three different approaches — frequency, intensity, and density — to identify Tornado Alley, the part of the country where most tornadoes occur. Finally, students will examine and compare seasonal differences in tornado occurrences.

Estimated time

Approximately 60 minutes

Materials

The student activity can be found at <http://esri.com/geoinquiries>.

Click on the Thinking Spatially Using GIS link and choose Module 4, Lesson 1.
Student activity: TS_M4L1_StudentDirections.pdf

Objectives

After completing the lesson, a student is able to do the following:

- Identify and compare regions in the United States
- Compare different map layers and identify relationships between them
- Identify spatial patterns and give reasons to explain them
- Identify temporal patterns and give reasons to explain them
- Analyze and compare the frequency, intensity, and density of tornadoes and learn about the differences between them
- Compare the geographic extent of different layers

GIS Tools and Functions

- Open a map file
- Zoom to the geographic extent of a layer
- Add a data layer to a map
- Identify to get information about a feature
- Use a filter to select features and records in a layer
- Open the attribute table for a layer

Functions

- Turn layers on and off
- Change map style (legend)
- Sort fields in a table

- Select records in a table
- Create a graduated symbols style in the legend
- Create a unique symbols style in the legend

National Geography Standards

Standard	K-4	5-8
5 That people create regions to interpret Earth's complexity	The concept of a region as an area of the Earth's surface with unifying geographic characteristics	The influences and effects of regional labels and images
7 The physical processes that shape the patterns of Earth's surface	How patterns (location, distribution, and association) of features on Earth's surface are shaped by physical processes	How to predict the consequences of physical processes on Earth's surface
15 How physical systems affect human systems	How variations within the physical environment produce spatial patterns that affect human adaptation	How natural hazards affect human activities

Teaching the lesson

Introducing the lesson

Begin this lesson by reviewing or discussing the following concepts.

- How the United States is made up of landforms and physiographic regions
- Three different aspects of tornado occurrence: frequency, intensity, and density
- Averages and how to calculate them
- How studying natural disasters can help you learn about weather, climate, landforms, and other aspects of geography
- How patterns of features on maps have spatial and temporal patterns
- Tornado dynamics
- How weather patterns change by season and by year

Student activity

We recommend that you complete this lesson yourself before completing it with students. This will allow you to modify the activity to accommodate the specific needs of your students.

Teacher Notes

- For younger grades, you can conduct the GIS activity as a teacher-led activity with students following along. You can lead students through the GIS steps and ask them the associated questions as a class.
- For older grades, ideally, students will have access to their own computers, but students can complete the activities in groups or under the direction of a teacher.
- Throughout the GIS activity, students are presented with questions. The GIS activity is designed so that students can mark their answers directly on these sheets. Alternatively, you can create a separate answer sheet.
- We recommend that students save their work as they progress through the GIS activity. Students can use either the Save command (to save their changes to the original map) or the Save As command (to save their changes to a new map). Please explain to students where and how they should save their work.

The following are things to look for while the students are working on this set of activities:

- As students work through the steps, are they thinking about the underlying geographic concepts (e.g., Are they looking for spatial patterns? Are they looking for relationships between features and layers? Are they relating temporal patterns to what they know about seasons of the year?)?
- Are students answering the questions in the GIS activity as they work through the steps?
- Are students able to use the legends to interpret the map layers?
- Do students understand the concept of selecting and sorting records in a table?
- Do students understand the difference between attribute query (selecting features based on an attribute value) and spatial query (selecting features based on location)?

Concluding the lesson

- Engage students in a discussion about the observations and discoveries they made during their exploration of U.S. tornadoes.
- Ask students about their impressions of Tornado Alley.
- Ask students to characterize regions of the country based on what they have learned about U.S. tornadoes.
- Make three copies of the worksheet 2 called “Map of the 48 states.” After students complete the activity, ask them to create three maps of Tornado Alley based on frequency, intensity, and density.
- Have them compare these maps and discuss the differences.
- Has this activity raised any questions that students would like to explore further?
- How can GIS help students to learn about natural disasters?
- Has this activity changed students’ ideas about tornadoes?

Extending the lesson

- Ask students to determine how many tornadoes occurred in their state from 1995 to 2004.
- Ask students to determine the date and intensity of the tornado closest to where they live.
- Ask students to determine the number of tornadoes in each state. The following is a way to do this:
 - Select a state
 - Use the Buffer tool to select the tornadoes in that state

References

- <http://www.tornadochaser.net/tornalley.html>
- http://www.stemnet.nf.ca/CITE/tornadoes_alley.htm
- <http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html>
- http://www.aon.com/us/busi/risk_management/risk_consulting/impact_forecast_files/UnitedStatesTornadoSeasonality.pdf
- <http://www.photolib.noaa.gov/nssl/tornado1.html>

Student activity answer key

Answers appear in blue.


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Task 1: Open the map

Task 2: Enlarge the ArcGIS Online window

Task 3: Tornadoes of the United States

 **Q1: Look at your map. In what part of the country do most tornadoes occur? (Circle the correct answer.)**


- a. Eastern states
- b. Western states
- c. **Central and eastern states**

 **Q2: Do you see any states that don't have tornadoes? (Circle the correct answers.)**

- a. Yes
- b. **No**

 **Q3: Do you see any states that don't have tornadoes? (Circle the correct answer.)**

- a. Yes
- b. **No**

 **Q4: Look at your map. In what part of the country do most tornadoes occur? (Circle the correct answer.)**


- a. Rocky Mountains
- b. **Great Plains**

 **Q5: Look at your map. What is the name of this body of water? **Gulf of Mexico****

Cool, dry air comes from the land to the north of the Great Plains.


 **Look at your map. What is the name of this country? **Canada****

Task 4: States where tornadoes occur most often

 **Q7:** Look at your map and at the legend. In which state did tornadoes occur most often? *Texas*

 **Q8:** Write the names of these six states in Column 1 of your worksheet. (Some state names are filled in for you.)

Task 5: State where the strongest tornadoes happen.

 **Q9:** Look at the map. List two states that you think have a high number of strong tornadoes. *Answers may include Arkansas, Tennessee, Oklahoma, Texas, or Kansas.*

 **Q10:** What is the name of this state? *Answers may include Texas, Arkansas, or Tennessee.*

 **Q11:** How many strong and violent tornadoes did it have from 1995 to 2004? *Answers may include 31 (Texas), 35 (Arkansas), or 30 (Tennessee).*

 **Q12:** What is the name of this state? *Answers may include Texas, Arkansas, or Tennessee.*


 **Q13:** How many strong and violent tornadoes did it have from 1995 to 2004? *Answers may include 31 (Texas), 35 (Arkansas), or 30 (Tennessee).*

 **Q14:** Write the names of these six states in Column 2 of your worksheet. (Some state names are filled in for you.)


Step 6: States with the highest concentration of tornadoes.

 **Q15:** While clicking on each state, write the names of the states that have the most dense tornadoes in Column 3 of your “Tornado Alley” worksheet.

 **Q16:** How many states contain dense tornado areas? *11*


 **Q17:** Which states appear in all three lists? Write the names of these states at the bottom of your “Tornado Alley” worksheet under “States in Tornado Alley.” (Two state names have already been filled in for you.)

Step 7: Where tornadoes occur during the seasons.

 **Q18:** Look at the map. In what region of the country are most winter tornadoes? Hint: Look at the States legend to see the names and colors of the regions. (Circle the correct answer.)


- a. Midwest
- b. Northeast
- c. South

 **Q19:** How many tornadoes occurred in winter between 1995 and 2004? 784


 **Q20:** In what regions of the country are most spring tornadoes? (Circle the correct answers.)

- a. Midwest
- b. Northeast
- c. South
- d. West


 **Q21:** How many tornadoes occurred in spring between 1995 and 2004? 5,285

 **Q22:** Look at the map. List two differences between winter tornadoes and spring tornadoes. (Hint: You can turn both layers on at the same time or turn them on and off to compare them.) Answers may include the following:








- There are many more tornadoes in the spring.
- Winter tornadoes occur mostly in the South, with very few in the Midwest or Northeast.
- Spring tornadoes extend much farther north and west.
- Spring tornadoes cover a much bigger area of the United States.

 **Q23:** In what region of the country are most summer tornadoes? (Circle the correct answers.)

- a. Midwest
- b. Northeast
- c. South
- d. West

 **Q24:** Look at the map. List one difference between summer tornadoes and spring tornadoes. (Hint: You can turn both layers on at the same time or turn them on and off to compare them.) Answer may include the following:

- Summer tornadoes are more concentrated in the northern states.
- Spring tornadoes are more concentrated in the southern states.

-  **Q25:** How many tornadoes occurred in summer between 1995 and 2004? **4,380**
-  **Q26:** In what region of the country are most fall tornadoes? (Circle the correct answers.)
- a. Midwest
 - b. Northeast
 - c. **South**
 - d. West
-  **Q27:** How many tornadoes occurred in fall between 1995 and 2004? **2,173**
-  **Q28:** Which season had the most tornadoes?
- a. Winter
 - b. **Spring**
 - c. Summer
 - d. Fall
-  **Q29:** What is the peak season for the southern states (the season when the South has the most tornadoes)?
- a. Winter
 - b. Spring
 - c. Summer
 - d. **Fall**
-  **Q30:** What is the peak season for the northern states (the season when they have the most tornadoes)?
- a. Winter
 - b. Spring
 - c. **Summer**
 - d. Fall
-  **Q31:** Discuss with your classmates some possible reasons that the locations of tornadoes change with the season. Write down two possible reasons. **Answers may include the following:**
- **The temperature warms in the spring and summer.**
 - **More thunderstorms occur in the spring and summer.**
 - **The sun is farther north in the sky during spring and summer.**
 - **The temperature difference between warm and cold air masses is greater during the spring and summer, producing more thunderstorms.**

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Worksheet 1: Tornado Alley

Column 1	Column 2	Column 3
Highest average number of tornadoes	Highest number of strong or violent tornadoes	Highest tornado density
1. Texas	1. Arkansas	1. South Dakota
2. Kansas	2. Texas	2. Iowa
3. Florida	3. Tennessee	3. Nebraska
4. Oklahoma	4. Kansas	4. Illinois
5. Illinois	5. Oklahoma	5. Colorado
6. Nebraska	6. Mississippi	6. Kansas
7. Iowa	7. Illinois	7. Oklahoma
8. Colorado	8. Missouri	8. North Carolina
9. Minnesota	9. Iowa	9. Texas
10. Arkansas	10. Alabama	10. Arkansas
11. Alabama	11. Kentucky	11. Florida

States in Tornado Alley

1. Texas
2. Kansas
3. Oklahoma
4. Illinois
5. Iowa
6. Arkansas

