

# A GIS Lesson: Blown Away!

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## Background

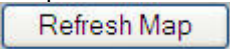
Since records of tornado activity were first kept in 1916, scholars and researchers have studied the 'How's & Whys?' of tornado development. Within the past few decades it has been found that tornados typically require three upper atmospheric conditions for formation.

1. A northerly flow of warm, moist air (mT) from the Gulf of Mexico
2. A cool, dry air mass (cP) descending from Canada regions
3. A jet stream wind exceeding speeds of 150mph

The region in the continental U.S. where cold, dry winds from Canada meets warm moist air from the Gulf of Mexico forms the U.S. jet stream. Scientist believe that the U.S. jet stream serves as a likely indicator of tornado position and intensity. In the activity below, try to refute or support this scientific theory using GIS (Geographic Information Systems). Load the 'Blown Away' AcrIMS application into your browser by going to <http://arcims.mathsciencecenter.info/website/blownaway/viewer.htm>

## Investigate

### A. Visual Survey: Observing data for patterns

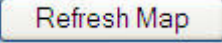


Conduct a brief visual survey of the map and the themes available. Experiment with the monthly tornado layers by turning each month's layers on, one at a time. Be sure to click the  button in the lower right corner after selecting new data layers.

1. How would you describe the locations and concentrations of tornados in the U.S. during the winter months? Turn on tornado layers January – March separately?
2. How would you describe the locations and concentrations of tornados in the U.S. during Spring? Turn on tornado layers April – June separately?
3. How would you describe the locations and concentrations of tornados in the U.S. during Summer and Fall? Turn on tornado layers July – December separately?

## B. Image Analysis: Layer-on-Layer selections

Turn on the Winter Jet Stream and January layers (be sure all other tornado and jet streams are turned off). Do you see any pattern between the U.S. jet stream and tornado occurrence? To help find the answer, we will do a layer-on-layer selection around the Winter Jet Stream of 200 miles and then tabulate the number of January tornados that might fall within that region.

To determine the number of tornado touchdowns meeting the above requirements:

- Make the following data layers visible by clicking on the square next to each layers name:  January  Winter Buffer  United States and be sure to click the  button after selecting the layers.
- Make 'Winter Buffer' the active layer by clicking the circle like:   Winter Buffer .
- Use the  'Select by Rectangle' tool and click on the image of the 'Winter Buffer' on the map. It should turn yellowish.
- Click on the  'Buffer' button and notice the bottom center window changes.
- In the bottom center window set the following 'Buffer' builder options
  - Highlight features from: **January**
  - Within a distance of: **200 miles**
  - Display attributes: **Checked**
  - Check to make sure your box appears as below
 

**Buffer**

Highlight features from January within a distance of 200 MILES around the selected features of Winter Buffer

Display Attributes
  - Press the **Create Buffer** button. This may take several seconds, be patient.
- The window below the map will display the tornados within 200 miles of the jet stream buffer. Use your mouse to scroll down in the bottom center window and give the number of tornados identified within 200 miles of the 'Winter Buffer'. \_\_\_\_\_ .


- What percentage of January tornadoes fall within 200 miles of the Winter Jet Stream buffer? (To calculate the percentage, divide the number of selected tornados by the total number of January tornados. The total number of tornados (by month) is indicated in the table at the bottom of this page.
- What percentage of May tornadoes fall within 200 miles of the Equinox Jet Stream buffer?
- What percentage of August tornadoes fall within 200 miles of the Summer Jet Stream buffer?
- Based on the information just recorded, what can you say about how tornadoes and the U.S. jet stream relate?

Reference Table 1: Total Tornadoes from 1950 to 1990, by month			
January	575	July	3390
February	958		2266
March	2312	September	1548
	4660	October	959
May	7081	November	1156
June	6306	December	786

### C. Querying Tables: Finding data beneath the surface

To find out more information, we can search through the data tables and determine how intense the tornadoes were by looking at the assigned Fujita scale. To obtain more information, we must conduct a 'query' of the data we selected above.

To identify January tornadoes with a Fujita scale of three or greater:

- Make the following data layers visible by clicking on the square next to each layers name:
   
  January   Winter Buffer   United States and be sure to click the **Refresh Map** button after selecting the layers.
- Make 'January' the active layer by clicking the circle like:   January .
- Click on the  'Query' button. Notice the bottom center window displays a Query Builder.
- Set the following 'Query' builder options
  - Field: **FUJITA**
  - Operator: **>=**
  - Value: **3** like
  - Press the **'Add to Query String'** button. Check to make sure your window appears as below
 

Field	Operator	Value	And	Or
FUJITA	>=	3	Not	( )
  - Press the **'Execute'** button
- A list of tornadoes meeting the criteria appears in the bottom center window. How many tornadoes have a Fujita scale of three or higher? \_\_\_\_\_.

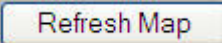
- What percentage of January tornadoes have a Fujita value equal or greater than three?
- What percentage of May tornadoes have a Fujita value equal or greater than three?
- What percentage of August tornadoes have a Fujita value equal or greater than three?

January	575	July	3390
February	958		2266
March	2312	September	1548
	4660	October	959
May	7081	November	1156
June	6306	December	786


## D. Continue Querying Tables: Finding data beneath the surface


To find out additional information, we can search through the data tables and determine how intense the tornadoes were by looking at the assigned Fujita scale. To obtain more information, we must conduct a 'query' of the data from the layers displaying tornadoes of F3 or greater.

To determine the number of tornado touchdowns meeting the above requirements:

6. Make the following data layers visible by clicking on the square next to each layers name:  January F3+  Winter Buffer  United States and be sure to click the  button after selecting the layers.

7. Make 'Winter Buffer' the active layer by clicking the circle like:   Winter Buffer .

8. Use the  'Select by Rectangle' tool and click on the image of the 'Winter Buffer' on the map. It should turn yellowish.

9. Click on the  'Buffer' button and notice the bottom center window changes.

10. In the bottom center window set the following 'Buffer' builder options

- Highlight features from: **January F3+**
- Within a distance of: **200 miles**
- Display attributes: **Checked**
- Check to make sure your box appears as below



Buffer

Highlight features from January F3+ within a distance of 200 MILES around the selected features of Winter Buffer

Create Buffer  Display Attributes

- Press the **Create Buffer** button. This may take several seconds, be patient.

6. The window below the map will display the tornados of F3 or greater within 200 miles of the jet stream buffer. Use your mouse to scroll down in the bottom center window and give the number of tornados identified within 200 miles of the 'Winter Buffer'. \_\_\_\_\_ .

11. What percentage of January tornadoes within 200 miles of the Winter Buffer have a Fujita value equal or greater than three?
12. What percentage of May tornadoes within 200 miles of the Winter Buffer have a Fujita value equal or greater than three?
13. What percentage of August tornadoes within 200 miles of the Winter Buffer have a Fujita value equal or greater than three?
14. What relationship do you see between Fujita values of tornado intensity during January, May, August? What trends or patterns exist in the data?
15. What role does seasonal variation in the U.S. jet stream have on tornado development? How does this role reflect the original scientific theory proposed above?
16. Are the test we conducted completely reliable for supporting or refuting these scientific claims? Why or why not?