

A photo of Hurricane Ivan making landfall over the southern United States on September 16, 2004.

Blowing in the Wind

North Atlantic hurricane analysis using Web GIS

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Hurricanes are among the most common—and destructive—natural hazards on the planet. These tropical cyclones are called hurricanes in the Northern Hemisphere, east of the International Date Line, and typhoons when they occur in the Pacific north of the equator and west of the International Date Line.

Have you ever considered that hurricanes are both temporal and spatial phenomena? Each hurricane has a beginning, a duration, and an end and is more likely to occur during certain seasons of the year. Hurricanes occur across space. Each hurricane has a beginning location when its classification changes from a tropical storm to a hurricane, a track across water and/or across land, and an ending location when its wind speed slows and it is no longer classified as a hurricane.

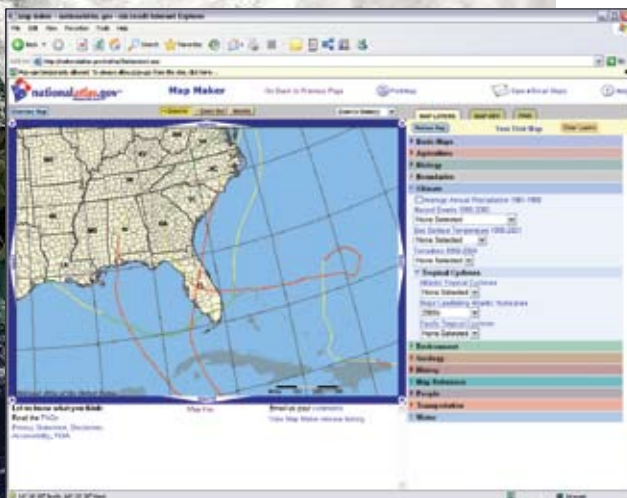
Hurricanes are spatial phenomena and can be better understood with maps, particularly digital maps in a GIS environment. GIS allows you to use maps as analytical tools. These aren't limited to maps that someone else has made. With GIS, you can make your own maps for solving problems and making decisions.

Your Mission

To better understand and prepare for the next hurricane season along the Gulf of Mexico and North Atlantic coast, you would like to investigate hurricanes that have occurred over the past 150 years. Your research on the spatial and temporal pattern of these hurricanes will include an analysis of hurricane tracks, wind speed, and pressure. You will discover how many hurricanes occur in specific countries and locations in the United States and how much land area is affected by hurricanes. You will map the results of these investigations. The first lesson in this series will guide you through the process using Web-based GIS through the National Atlas.



Select MapMaker from the National Atlas site to begin GIS investigations on the Web. Go to Base Maps and activate county and state boundary symbology.



Select Climate > Tropical Cyclones > Major Landfalling Atlantic Hurricanes > 2000s to map the large hurricanes that reached land.

Using Web-Based GIS

The National Atlas of the United States is a Web mapping service that lets visitors create maps of hundreds of phenomena from agriculture to Zebra mussels.

1. Begin making a map of hurricanes by accessing the National Atlas site (nationalatlas.gov) and selecting Map Maker. Make sure that the pop-up blocker on your browser is disabled.
2. On the right side of the resulting map is a series of map layers. Select Base Maps and check Counties, County Names, States, and State Names. Click Redraw Map.
3. Select Climate > Tropical Cyclones > Major Landfalling Atlantic Hurricanes > 2000s to map the large hurricanes that reached land. The data was collected by the National Hurricane Center (NHC), part of the National Oceanic and Atmospheric Administration. Select Redraw Map.
4. Notice that the North Atlantic Ocean is the birthplace of these hurricanes. Interestingly, many originate very close to the North Africa shoreline. Most hurricanes begin over water and most—but not all—hurricanes eventually make landfall. Examining this data in a Web-based GIS makes it starkly clear why coastal populations are especially vulnerable to hurricanes. Use the Identify tool, located above the map, to identify some of the hurricanes displayed. Examining the map, answer the following questions:
 - In which direction do most of the hurricanes move, and why? Despite the movement of most hurricanes from the southeast to the northwest, and then

[Credits] Jacques Desloires, MODIS Land Rapid Response Team, NASA SFC, Terra satellite

Summary

Finding suitable teaching materials is one of the challenges teachers who want to incorporate GIS in science classes face. This tutorial uses the National Atlas of the United States, a Web mapping service available at no charge that requires only a Web connection. The tasks in this tutorial can typically be accomplished in one hour or less.



Use the Identify tool to learn more about some of the hurricanes displayed.

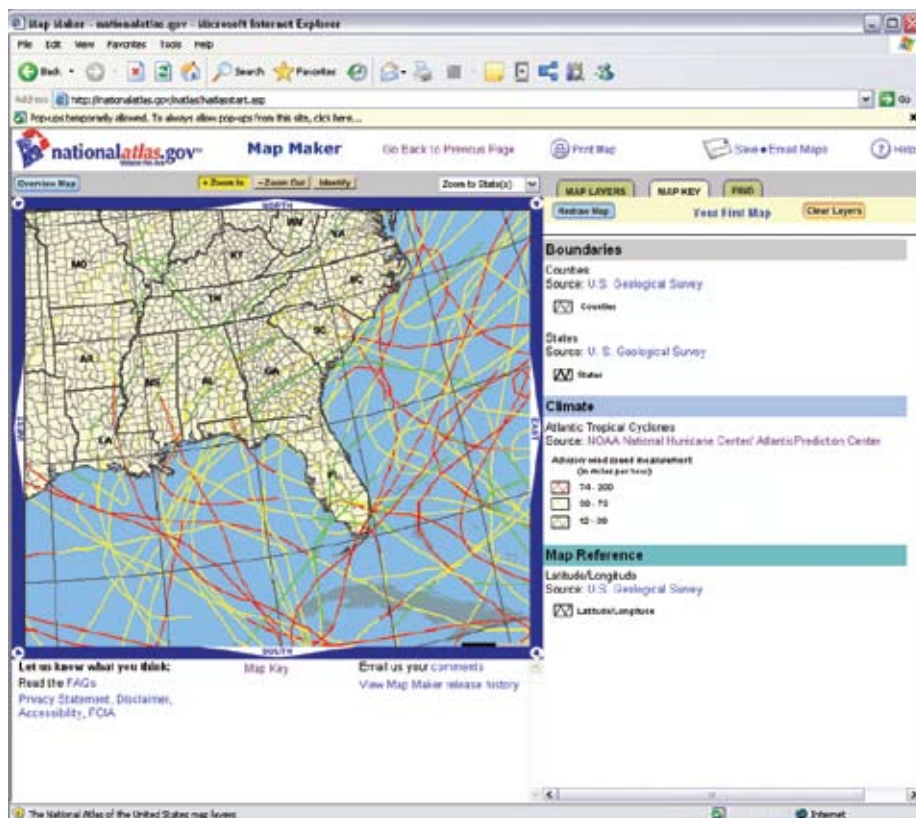
moving northeast after encountering the jet stream at higher latitudes, many hurricanes do not fit the pattern. Hurricane Ivan, for example, moved from the North Atlantic to the Gulf of Mexico in September 2004. As of this writing, the hurricane data covers years from 1851 to 2004. Other countries besides the United States are affected by hurricanes.

- What are the names of these countries?
- Which three countries are the ones most frequently visited by North Atlantic hurricanes?
- Which three states in the United States seem to be most frequently visited by hurricanes?

Hurricanes through Time

Next, map hurricanes from different decades by choosing Climate > Tropical Cyclones > Major Landfalling Atlantic Hurricanes and selecting other decades from the drop-down list. Remember to select Redraw Map each time.

- Would you say that the frequency of hurricanes is increasing, decreasing, or remaining about the same each decade?
- Keeping in mind the techniques used to track hurricanes during the 19th century versus the 21st century, how much of your judgment of hurricane frequency depends on the quality of the data from the 19th century?
- What characteristic of North Atlantic hurricanes is similar for each decade?
- Which decade looks to be the decade when most hurricanes reached land?



Selecting and displaying all Atlantic hurricanes for the decade of the 2000s

Zoom in on the southeastern United States. Select Map Key in the upper right corner to display the key, or legend, for these hurricanes. Notice that the hurricanes are colored based on their wind speed in miles per hour.

- What do you observe about how the wind speed changes as the hurricanes move across the ocean and across land?

Think about the implications that these changes in hurricane wind speeds have on the destructive power of hurricanes. Thus far, you have been examining the major hurricanes that reached land. In the map layers list on the right side of the map, change the layer to Atlantic Tropical Cyclones (hurricanes), 2000 to look at all hurricanes in the database for that decade, rather than just major ones that reached land.

- How do you think the pattern of all Atlantic hurricanes (cyclones) compares to the major landfalling hurricanes of the same decade, and why?

- How does the number of all Atlantic hurricanes (cyclones) compare to the major landfalling hurricanes of the same decade, and why?

Conclusion

The National Atlas allows you to study spatial phenomena online. While Web-based GIS is rapidly expanding in terms of the data and functionality available, more robust investigations are possible in a desktop GIS environment. Using the National Atlas, you are limited by the datasets available, symbology used, and attributes that you can map. Lessons in future issues of *ArcUser* will continue these hurricane research activities using ArcExplorer Java Edition for Education and ArcGIS Desktop 9.2. Each successive tool will enable you to ask more probing questions and more fully model and investigate the relationships, patterns, and trends of spatial phenomena.