



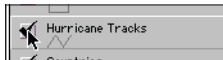
## Activity 1.2

### Things to know...

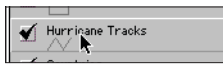
The ► symbol between two boldface words in text indicates a menu choice. Thus, **File ► Open...** means “pull down the File menu and choose Open... from the menu.”

**How to zoom in and out.** Use the Zoom In  and Zoom Out  tools. To see the entire map again, choose View > Full Extent.

**To turn a theme on or off,** click its checkbox in the Table of Contents.



**To activate a theme,** click on its name in the Table of Contents. Active themes are indicated by a raised border.

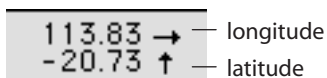


### Hurricane Andrew movie



The Hurricane Andrew movie is an animated sequence of GOES weather satellite images, showing the motion and development of the storm.

**Reading coordinates:** The cursor's longitude and latitude are displayed on the right end of the tool bar.



# Discovering cyclone patterns

Tropical cyclones are among the most powerful and destructive natural phenomena on Earth. In one day, a tropical cyclone releases enough energy to supply the electrical needs of the United States for six months! Called hurricanes, cyclones, or typhoons depending on where they occur, these massive storms kill thousands of people and cause billions of dollars in damage each year.

## A global view

In this activity, you will investigate where and when tropical cyclones form, to help you understand the conditions that create and maintain these huge storms.

- ▶ Launch the ArcView GIS application, then locate and open the **cyclones.apr** project file.
- ▶ Open the **Global Patterns** view.

The green symbols show the starting point of each of the 4332 tropical cyclones recorded between 1950 and 2000. Keep in mind that each dot represents the beginning of a storm that affected a broad area. To illustrate the size of these storms, you will look at an animated series of weather satellite images of North America from 1992.


- ▶ Click the Media Viewer button  and choose the **Hurricane Andrew Movie** from the list. After the QuickTime Player application loads the file, click the play button to view the movie.

The movie covers a six-day period from August 22–27. At the beginning of the movie, you should see Hurricane Lester making landfall on the west coast of Mexico. A day or two later, Hurricane Andrew crosses Florida before slamming into Louisiana.

1. In which direction do Andrew and Lester spin—clockwise or counterclockwise?
2. What happens to both storms when they cross over land?

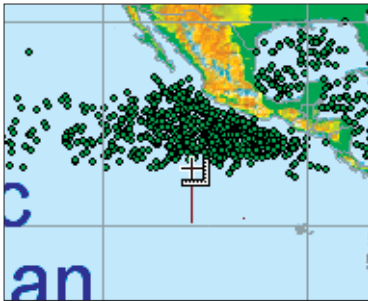
- ▶ Close the QuickTime Player application when you are finished viewing the movie.
  - ▶ Now, look at the distribution of hurricanes on the map. Using the latitude lines on the map, estimate the northern and southern boundaries of the region where tropical cyclones form.
3. Most tropical cyclones form between about \_\_\_\_\_ °N latitude and \_\_\_\_\_ °S latitude.

**Zooming in quickly**




The quickest way to zoom in on an area is to use the Zoom In tool  to click and drag a rectangle around the region you want to fill the view.

**Using the Measure tool **

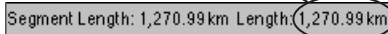
To measure the distance between two points, click the Measure tool's crosshair cursor on one point, move the crosshair to the other point, and read the distance in the status bar. Double-click to stop measuring.



Look closely at the area near the equator. There appears to be a narrow, "cyclone-free zone" centered on the equator.


- ▶ Using the Zoom In tool  zoom in on this cyclone-free zone, and use the Pan tool  to drag the map along the equator.
- ▶ Move your cursor along the boundaries of the zone and note the latitude in the coordinate display at the right end of the tool bar.
- ▶ Use the Measure tool  to measure the distance from the equator to the edge of the cyclone-free zone, as shown at left. The distance (Length) is given in the status bar.

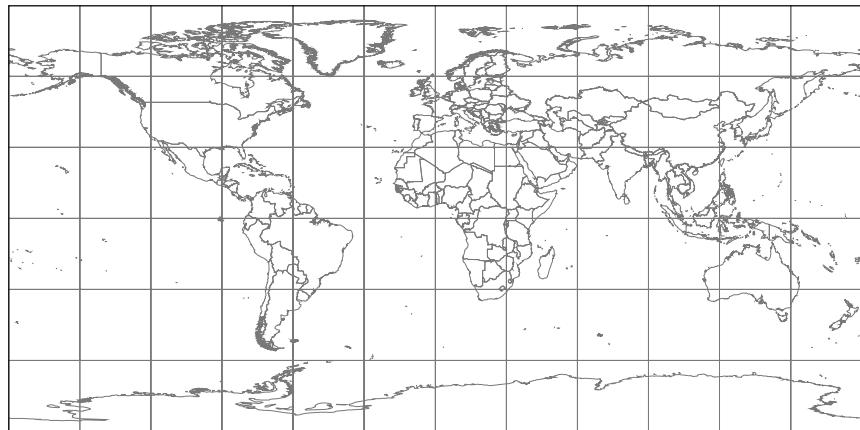
read distance here (your distance will vary)



4. The cyclone-free zone extends approximately \_\_\_\_\_ degrees or \_\_\_\_\_ kilometers from the equator.

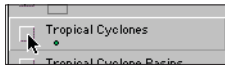
For now, it's enough to know that tropical cyclones don't form in this band. Later, you'll learn *why* they don't form there.

- ▶ Click the Zoom to Full Extent button  to display the entire map again.
5. Symmetrical patterns are very common in nature. In what areas of the world oceans, besides those very near the equator and the poles, would symmetry lead you to expect tropical cyclones to form, yet they don't? Identify these areas on the map below.

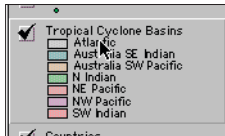


6. Explain why you expect tropical cyclones to form in these areas.

To turn a theme on or off, click its checkbox in the Table of Contents.



To activate a theme, click on its name in the Table of Contents.



**What's in a name?**

**Cyclone** comes from the Greek word *kuklos*, meaning circle. Indeed, tropical cyclones not only spin, but they usually move along curved paths.

**Hurricane** comes from *Hurakán*, the Mayan god of the skies and lightning. He created the world by endlessly repeating the word "earth" until the solid ground rose from the seas. When he became angry with the first human beings, Hurakán unleashed the rain and wind that destroyed them. Hurakán translates literally as "one-legged."



**Typhoon** comes from the Japanese word *taifuu*. The characters translate literally as "pedestal wind," a very vivid description!


台 tai = pedestal  
風 fuu = wind

**Tropical cyclone basins**

Within the range of latitudes you observed, the tropical cyclones aren't distributed evenly around the globe. Instead, they occur in large clusters. These clusters help define tropical cyclone basins.

- ▶ Turn off the **Tropical Cyclones** theme.
- ▶ Turn on and activate the **Tropical Cyclone Basins** theme.

This theme shows seven major regions, called basins, where tropical cyclones form. Each basin is identified by the ocean in which it occurs and the land areas affected by its storms. A storm's name also depends on the basin in which it forms.

- ▶ To learn more about these basins and answer the questions below:
  - Click on each basin using the Identify tool .
  - Close each **Identify Results** window when you are done with it.

7. In the table, record the hemisphere, direction of rotation, average number of cyclones per year, and storm name for each basin.

Tropical Cyclone Basin Name	Hemisphere (N / S)	Storm rotation (CW / CCW)	Average number of tropical cyclones per year	Name of storm (from [Type] field)
Atlantic				
Australia SE Indian				
Australia SW Pacific				
N Indian				
NE Pacific				
NW Pacific				
SW Indian				

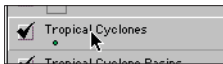
Using the information from your table, answer the following questions.

8. What are all tropical cyclones in the southern hemisphere called?
9. What would you call a tropical cyclone that strikes Japan—a cyclone, a typhoon, or a hurricane?
10. In which direction do storms in each hemisphere rotate?
  - Northern = \_\_\_\_\_
  - Southern = \_\_\_\_\_

### When do tropical cyclones occur?

For people living on the Atlantic and Gulf Coasts, a typical year has *five*, not four seasons. The fifth season is hurricane season. With it comes the fear that it might just be the year of “THE BIG ONE.” Is tropical cyclone season the same everywhere on Earth? To find out, you will change the legend to show the time of year during which each storm occurred.

To edit a theme’s legend, double-click the name of the theme in the Table of Contents.



- ▶ Turn on and activate the **Tropical Cyclones** theme.
- ▶ To change the **Tropical Cyclones** legend:
  - Double-click the **Tropical Cyclones** theme title in the legend to open the Legend Editor.
  - Click the **Load** button, open the **Data** folder, then open the **seasons.avl** file.
  - In the next dialog box, choose **Dates** from the **Field** popup menu and click **OK**.
  - Click the **Apply** button, then close the Legend Editor window.

Each tropical cyclone should be colored according to the time of year when it formed. (If not, repeat the process or ask your instructor for help.)

- ▶ Use the Zoom In tool to magnify each of the tropical cyclone basins. For each basin, note the predominant color of the tropical cyclones and find the corresponding dates in the legend.
11. For each tropical cyclone basin, record the hemisphere and dates of greatest tropical cyclone activity in the table below. Use the information at left to convert each range of dates to a season.

#### Earth’s Seasons

Earth’s seasons are

- caused by the tilt of Earth’s axis,
- defined according to the elevation of the sun in the sky, and
- opposite in the northern and southern hemispheres.

Dates	Hemisphere	
	Northern	Southern
Dec 21 - Mar 19	Winter	Summer
Mar 20 - Jun 20	Spring	Fall
Jun 21 - Sep 21	Summer	Winter
Sep 22 - Dec 20	Fall	Spring

Tropical Cyclone Basin Name	Hemisphere (N / S)	Range of dates of greatest tropical cyclone activity	Season (see table at left)
Atlantic			
Australia SE Indian			
Australia SW Pacific			
N Indian			
NE Pacific			
NW Pacific			
SW Indian			

12. According to the table, regardless of the hemisphere, during which season of the year do most tropical cyclones occur?

## Activity 1.4

## Powering tropical cyclones

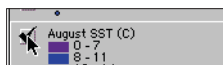
Energy from the sun drives Earth's weather. Solar radiation travels through space and Earth's atmosphere and is absorbed by Earth's surface. As the surface heats up, it warms the air above the surface. Our weather is complex for two reasons: Earth's surface doesn't heat up evenly, and the planet is spinning.

**Energy for tropical cyclones**

So far, you've seen that tropical cyclones form only within a limited range of latitudes and that they usually form during the summer and early fall in the northern and southern hemispheres. This seasonal pattern appears to be related to the warming of Earth's surface by the sun. What temperature range do tropical cyclones form in, and is there some minimum temperature below which tropical cyclones don't form? In this part of the activity, you will try to answer these and other questions.

- ▶ Launch the ArcView GIS application, then locate and open the **cyclones.apr** project file.
- ▶ Open the **Powering Tropical Cyclones** view.
- ▶ Turn on the **August SST (C)** theme.

To turn a theme on or off, click its checkbox in the Table of Contents.



This theme shows the average sea surface temperature (SST) in degrees Celsius (°C) for the month of August, the warmest summer month in the northern hemisphere.

Working with temperatures in Celsius instead of Fahrenheit can be confusing at first. To get a better feeling for the temperatures involved, you will convert two temperatures from Fahrenheit to Celsius.

1. Use the conversion  $^{\circ}\text{C} = (5/9) \times (^{\circ}\text{F} - 32)$  to convert  $70^{\circ}\text{F}$  and  $80^{\circ}\text{F}$  to degrees Celsius (°C). Round to the nearest degree.

$$70^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$$

$$80^{\circ}\text{F} = \underline{\hspace{2cm}}^{\circ}\text{C}$$

Read the legend to answer the following questions about the sea surface temperature.

2. What color represents the warmest water? What is the temperature of the warmest water?
3. In August, water with a temperature of  $27\text{--}28^{\circ}\text{C}$  is found as far north as  $\underline{\hspace{2cm}}^{\circ}\text{N}$  and as far south as  $\underline{\hspace{2cm}}^{\circ}\text{S}$  latitude.
  - ▶ Turn off the **August SST (C)** theme and turn on the **February SST (C)** theme.
4. In February, water with a temperature of  $27\text{--}28^{\circ}\text{C}$  is found as far north as  $\underline{\hspace{2cm}}^{\circ}\text{N}$  and as far south as  $\underline{\hspace{2cm}}^{\circ}\text{S}$  latitude.

**Temperature Conversions**

$$^{\circ}\text{C} = (5/9) \times (^{\circ}\text{F} - 32)$$


$$^{\circ}\text{F} = ((9/5) \times ^{\circ}\text{C}) + 32$$

**Reading coordinates:** The cursor's longitude and latitude are displayed on the right end of the tool bar.

113.83 →	longitude
-20.73 ↑	latitude

**Sea surface temperature and the seasons**

To see how the sea surface temperature changes throughout the year, a series of SST maps have been assembled into a movie.

- ▶ To view the movie, click the Media Viewer button  and choose **SST Movie** from the list. You can step through the movie a frame at a time using the left and right arrow keys on the keyboard.

Click the play button and watch the movie several times. The colors represent the sea surface temperature averaged over a nine year period.

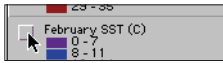
5. How does the shift in sea surface temperature reflect the seasons in the northern and southern hemispheres?

- ▶ Close the movie window when you are finished viewing the movie.
- ▶ Turn off the **February SST (C)** theme.

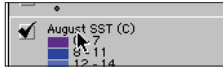
**Earth's seasons**

Dates	Hemisphere	
	Northern	Southern
Dec 21 - Mar 19	Winter	Summer
Mar 20 - Jun 20	Spring	Fall
Jun 21 - Sep 21	Summer	Winter
Sep 22 - Dec 20	Fall	Spring

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To activate a theme, click on its name in the Table of Contents.



**Searching for a threshold temperature**

Is there some minimum temperature needed to form tropical cyclones? To find out, you will use the Legend Editor to classify tropical cyclones according to the temperature of the ocean surface over which they formed.

- ▶ Turn on and activate the **Tropical Cyclones (Aug)** theme.

This theme shows the starting location of every tropical cyclone that occurred during the month of August from 1950 to 2000. The theme's data table also includes the average August sea surface temperature for that location, in degrees Celsius.

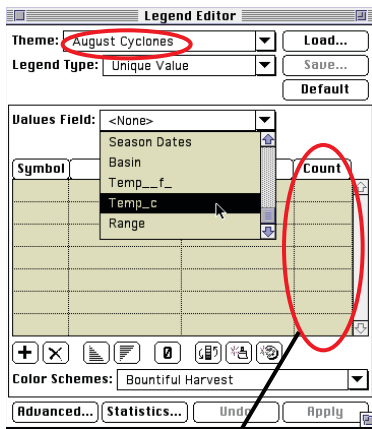
- ▶ To classify the August tropical cyclones according to the average temperature of the ocean surface over which they formed:
  - Double-click the **Tropical Cyclones (Aug)** theme in the Table of Contents to open the Legend Editor window. (see left)
  - Set the **Legend Type** to *Unique Value* and the **Values Field** to *Temp\_C*.
  - Read the number of cyclones that formed at each temperature in the **Count** column.

6. Record your results in the table below.

Temperature (° C) ➔	25	26	27	28	29	30
# of Tropical Cyclones - August						N/A
# of Tropical Cyclones - February						

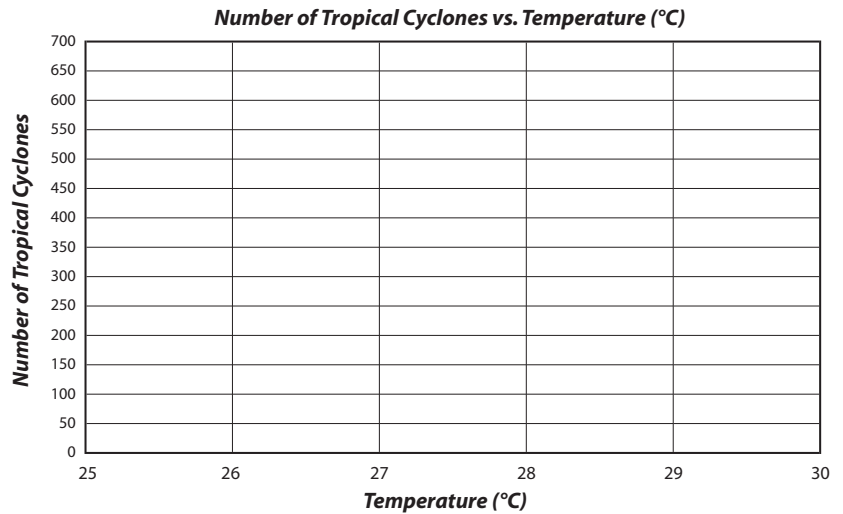
- ▶ Close the Legend Editor window.
- ▶ Turn off the **Tropical Cyclones (Aug)** theme and turn on and activate the **Tropical Cyclones (Feb)** theme.
- ▶ Repeat this process to classify the February tropical cyclones according to temperature and record the results in the table.

**Creating a unique value legend**



Read the number of cyclones that formed at each temperature in the **Count** column of the Legend Editor. Ignore the 9999 value - it was used if the temperature of formation was uncertain.

- Plot the number of tropical cyclones versus temperature (°C) for August and for February on the graph below. Use a solid line for August and a dashed line for February.



- Using the graph, at what temperature do tropical cyclones first appear in the northern (August) and southern (February) hemispheres?
- At what temperature do they occur most frequently?

Draw a vertical line on the graph at 26.7°C. This is the temperature that experts say is needed for a tropical cyclone to form.

- How well do the data you graphed agree with the experts?

**Hint for question 11**

Look at one of the sea surface temperature themes. What would a graph of the sea surface temperature versus area look like?

**What do the scientists say?**

For a detailed though somewhat technical discussion of the effects of global warming on tropical cyclone formation, visit Christopher Landsea's *FAQ: Hurricanes, Typhoons, and Tropical Cyclones* website at:

<http://www.aoml.noaa.gov/hrd/tcfaq/tcfaqG.html#G3>

- Logically, the warmer the water, the more tropical cyclones you should have. Why do you think the number of tropical cyclones on the graph actually decreases for temperatures above 28°C?
- If global warming is a real phenomenon, and ocean temperatures increase worldwide, how do you think this could affect the frequency (how often), latitude range, and intensity of tropical cyclones. Justify your answer.

