"When Nature Strikes – Hurricanes" Narrative

Hurricanes--also called tropical cyclones or typhoons—are among the world's most dangerous natural hazards. Every year they threaten millions of people in many parts of the world with death and destruction. These huge, powerful, low-pressure systems produce heavy rain, high winds, storm surges, inland flooding, and other damage.

People in the areas affected by hurricanes have known about them for thousands of years, but Europeans first became aware of them when Christopher Columbus experienced one during his final voyage in 1502. Residents living today along the Gulf of Mexico and East Coast are very familiar with hurricanes, as are those in the Caribbean, Hawaii, and Pacific Islands. Tropical cyclones and typhoons impact the shores of the Eastern, Central, and Western Pacific Ocean, Indian Ocean, Australia, and elsewhere.

"When Nature Strikes – Hurricanes" describes cutting-edge research about forecasting storm paths and intensity, and the historical record of past events. This learning activity will help you answer these questions:

- What are hurricanes?
- Where do hurricanes usually occur? Where are they unlikely to occur?
- How likely are they to affect your home area?
- How do we monitor and predict their movements?
- Why is it so difficult to forecast the track of a hurricane?

Part 1. What are hurricanes?

You can begin to get a better understanding of what hurricanes are through resources provided by the "Jet Stream Online School for Weather" and the "National Hurricane Center Hurricane Resources." Use these readings, videos, or other background sources to complete the table about basic stages in a hurricane's 'life story.' This tropical storm classification information may be of special value.

| Name | Range of wind speeds | Other characteristics |
|------|---------------------|----------------------|
| "tropical depression" | | |
| "tropical storm" | | |
| "hurricane" | | |

Once it forms, the intensity of hurricanes is usually described through the Saffir-Simpson Scale. It ranges from Category 1 storms with winds 74 – 95 mph (119 – 153 km/h) up to Category 5 events with winds in excess of 157 mph (252 km/h). Categories 3 (minimum winds 111 mph (178 km/h), 4, and 5 are described as "Major" and produce the greatest damages. During the lifetime of most storms, the categories will change depending on a variety of factors which provide energy to the system.

Hurricanes are often described as "heat engines" that take warm waters and convert them into the clouds that run the storm. The typical structure of a hurricane is shown in Fig 1.
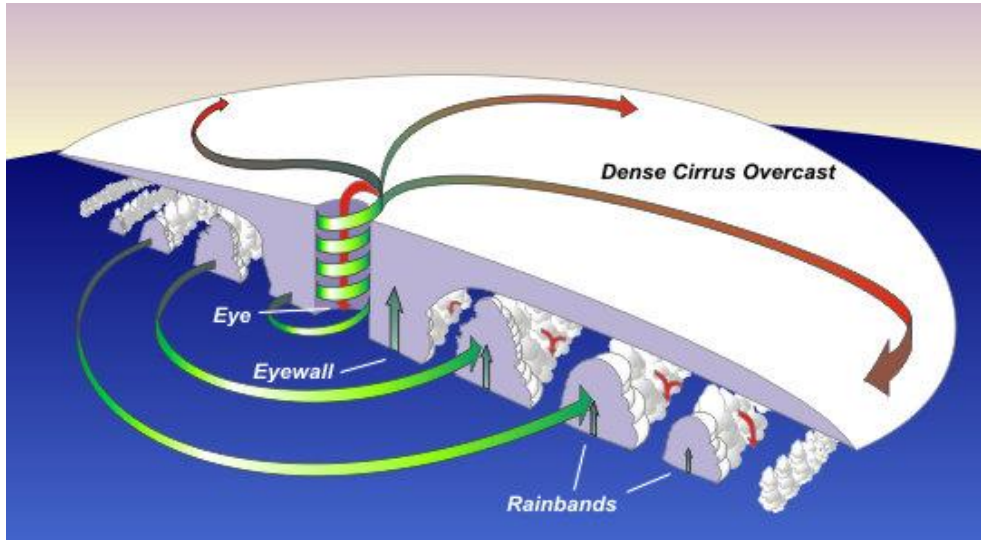
Briefly explain what happens in each part

| Eye | |
|-----|---|
| Eyewall | |
| Rainbands | |
| Cirrus overcast | |



Fig. 1  Source: http://www.srh.noaa.gov/jetstream/tropics/tc_structure.htm

Part 2. Where have hurricanes and other tropical cyclones occurred in the past? How likely are they to affect your area?

Hurricanes are most likely to form when the right "ingredients" come together and are unlikely to develop under other conditions. Read through your online and other resources to learn more and then complete the table below to explain whether each factor supports or inhibits "cyclogenesis" (fancy word for forming a storm).

| Factor | Support or Inhibit? | Reason |
|--------|---------------------|--------|
| Sea Surface Temperatures at least 26 deg C (79 deg F) | | |
| SST lower than 26 deg C | | |
| Within 5 deg Lat of the Equator | | |
| 5 – 20 deg N or S of the Equator | | |
| Moist troposphere | | |

| | | |
|---|---|---|
| Dry troposphere | | |
| Strong winds above the surface | | |
| Light winds through troposphere | | |

Now examine the map above which shows typical tropical storm paths. Then answer these questions:

- In what parts of the Northern Hemisphere ocean basins do hurricanes occur?
  _____

- Where in the Northern Hemisphere oceans are hurricanes uncommon or non-existent?
  _____

- In what parts of the Southern Hemisphere ocean basins do hurricanes occur?
  _____

- Where in the Southern Hemisphere oceans are hurricanes uncommon or non-existent?
  _____

  Based on what you now know about the factors that may lead to cyclogenesis and this map, answer these questions:

- What conditions exist in areas where storms form that 'rev up the heat engine'?

  | Your explanation: |
  |---|
  | |

- What conditions exist in other areas that prevent tropical cyclones from forming?
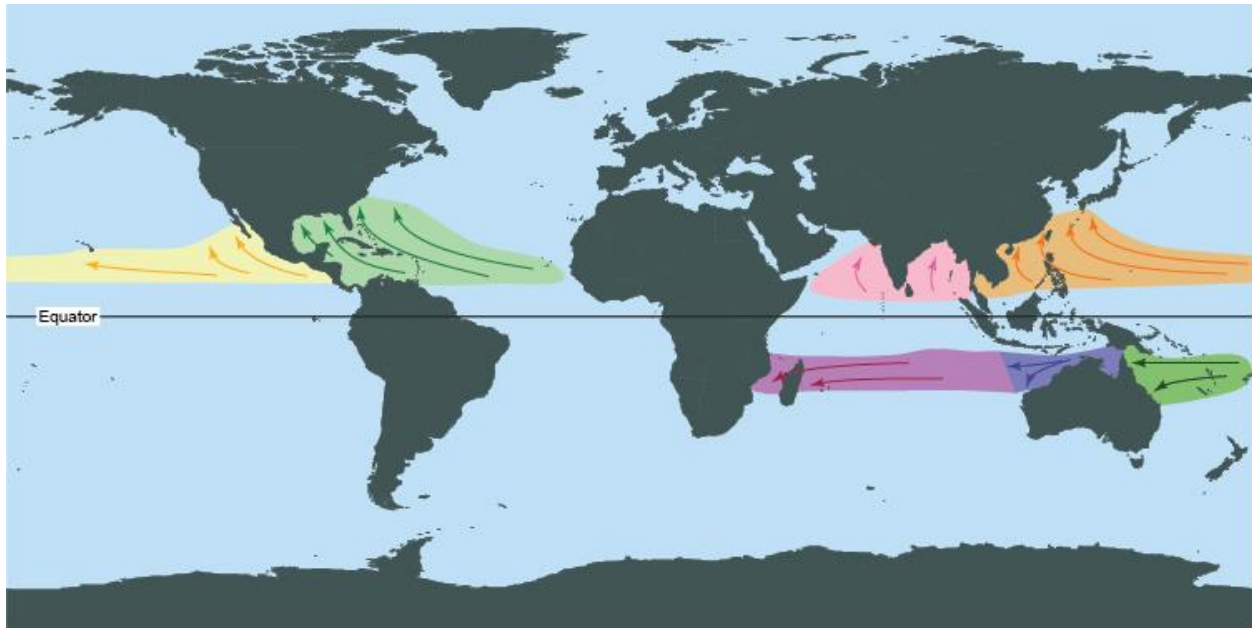
  | Your explanation: |
  |---|
  | |

Fig. 2  Source: http://www.srh.noaa.gov/jetstream/tropics/tc_basins.htm

 Part 3.  How likely are hurricanes to affect your home area?

      Because of the potentially devastating impact of hurricanes and other tropical storms, the National Hurricane Center has created a Tropical Cyclone Climatology that provides summaries of historical events in the Atlantic and Pacific, origins and tracks by month, and many additional resources.

      One of these is this interactive resource which allows you to identify any location, such as your home area, and then examine tracks of storms that have impacted the region during the past decades.

      Explore what this resource tells you about hurricane history in your own location, and write about what you have learned by continuing with this sentence prompt:

> In the area where I live, hurricanes

Part 4.  How do we observe and monitor hurricanes?

      Perhaps the deadliest hurricane in US history occurred one day in 1900 when as many as 10,000 people perished on Galveston Island, TX, during a storm that could not be well forecast with then-existing technology. Today, although we cannot prevent storms from affecting an area, we have a wide array of technologies to watch them as they form and monitor their movement toward populated areas.

Most important among our resources are GOES (Geostationary Observational Environmental Satellites) which provide continuous, up-to-the-moment observations from space around the globe. GOES and other satellite missions operate continuously to collect  data about clouds, sea surface temperatures, and other factors needed by forecasters to predict tropical storms and other weather systems. You can view the latest satellite imagery to see if there are any active systems around the world.

Once a storm approaches a populated area, the National Weather Service and others depend on Doppler weather radar to obtain more detailed information about wind, rainfall, and other conditions. These technology systems, combined with satellites, ground-based instrument arrays, and powerful computer models, provide meteorologists with detailed observations necessary to forecast the paths of storms and their strength.

As the "When Nature Strikes" video makes clear, it is very difficult to predict that exact path that a storm will take. Often, the National Hurricane Center will try to indicate visually the possible areas that may be affected by a storm using a "track forecast cone." This method shows where the storm may be during the next 120 hours (3-1/2 days). Here is one example:



http://www.nhc.noaa.gov/aboutcone.shtml
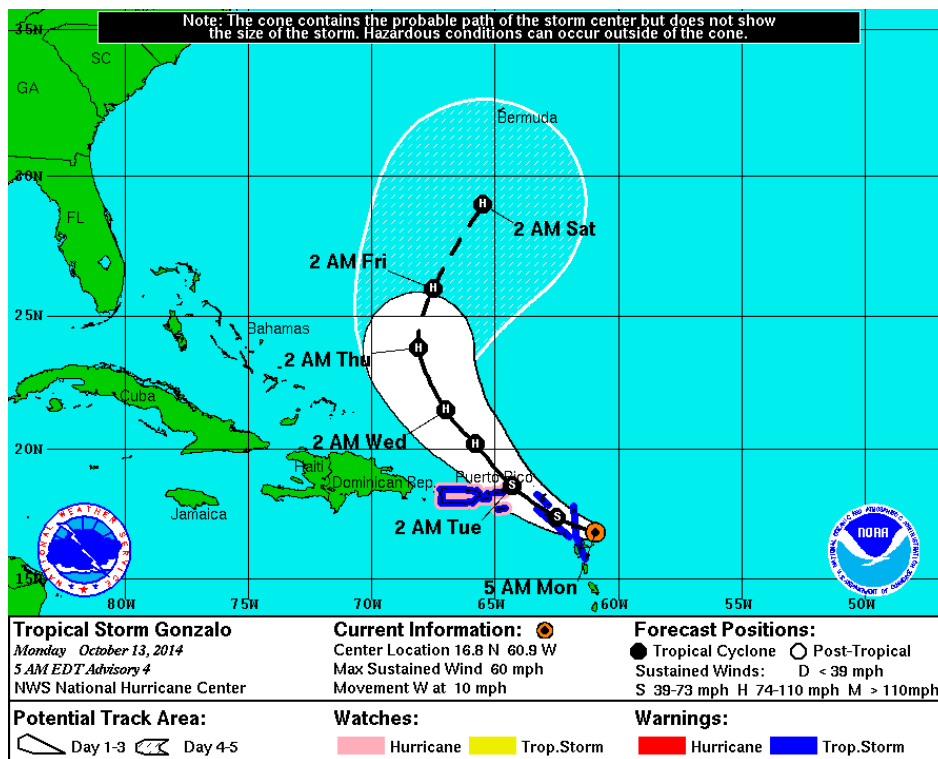
Read some of the resources linked above to know more about how we can predict storm paths and intensities. Write a 4 – 5 paragraph essays explaining how we can observe and monitor tropical cyclones.

Part 5.  Why is it so difficult to forecast the track of a hurricane?

You might think that it would be easy to use all the satellite, radar, computer models, and expertise of hurricane specialists to make accurate forecasts of storm paths and strength, but experience shows it is not. We now know much about how weather behaves, but there are still many uncertainties about our understanding of the physical laws controlling atmosphere behavior, limitations of how detailed we can make the computer models, and possible errors in the observations and algorithmic equations used in the models. Read more about hurricane forecast computer models.

The National Hurricane Center specialists examine results from many track and intensity models to make their forecasts. The NHC does not create graphics of the models used to produce forecasts because such graphics may be confusing to the general public and undermine the effectiveness of NHC forecasts. Those interested in knowing more about the NHC tropical cyclone discussion products can find out more.