BASIC UNDERSTANDINGS Hurricanes

Hurricane Development

1. A hurricane is an intense rotating storm system that forms over warm tropical waters typically in the late summer or early fall.

2. Hurricanes are circular in shape, ranging from 300 to 1,000 km across, and have winds over 118 km/h within 50 kilometres of the centre.

3. The formation of a hurricane requires a low pressure disturbance over a large expanse of warm water. The evaporation of this water will intensify the resulting storm.

4. This formation must be far enough from the Equator so that winds will circulate around a centre of low pressure due to the Coriolis force. The Coriolis force is too weak near the Equator to create the needed rotation.

5. Certain wind patterns at various altitudes are also needed to ensure that the developing hurricane will not simply blow apart.

6. The hurricanes that strike North America form in the tropical North Atlantic and Caribbean and move on a westerly to northerly track, steered by the prevailing winds. They strike the mainland on either the Gulf or Atlantic coasts.

7. **The tropical disturbance** stage of hurricane development is characterized by a collection of thunderstorms forming in the easterly flow over warm tropical waters with only a slight rotation.

8. **The tropical depression** stage is a well-defined centre of low pressure with winds of 37 to 62 km/h.

9. **The tropical storm** stage is characterized by an intense centre of low pressure and winds of between 63 and 117 km/h.

10. **The hurricane** stage occurs when the wind speed exceeds 117 km/h.

Hurricane Features

11. The major feature within a hurricane is the eye, a small region of relatively calm and clear air in the centre, 15 kilometres or so across.

12. The eye is surrounded by the eye wall where the weather is most severe with high winds and heavy precipitation.

13. Feeding into the wall cloud region are spiral rain bands often embedded with vigorous thunderstorms.

14. The forward movement of hurricanes is slow, typically 15 to 25 km/h in the lower latitudes.

15. The path of the hurricane is determined by the complex interactions with wind currents aloft and the existing large-scale weather patterns. The resulting path can be erratic and difficult to forecast.

16. In a hurricane, the observed wind speed is largely determined by the combined forward and spinning motions of the storm. On one side of the eye, the wind speed is increased by the forward motion of the storm and on the other side, the wind speed is decreased by this motion.

17. Since hurricanes get their energy from the evaporation of warm tropical water, as they move over colder water or land, they lose their energy source and weaken in intensity.

Hurricane Hazards

18. The low pressures and high winds associated with hurricanes create huge mounds of water called storm surges which cause 90% of all hurricane deaths. Large-scale evacuations of people from low-lying areas can prevent the massive loss of life due to such flooding.

19. Severe thunderstorms and tornadoes are often associated with the convective activity in hurricanes.

20. Hurricane winds have been recorded at speeds up to 300 km/h. Beyond the direct damage caused by such winds, wind-driven waves on top of the storm surge compound the flooding problem by battering and eroding the coastal landscape and structures.

21. The Canadian Hurricane Centre begins issuing bulletins about tropical storms or hurricanes when one is forecast to enter Canada's Response Zone within 72 hours. (see map of the Response Zone on page 17 — as well, there is a lot of other information about hurricanes on the Canadian Hurricane Centre's web site: **www.ns.ec.gc.ca/weather/hurricane**)

NARRATIVE Hurricanes

What is a Hurricane?

A hurricane is an intense rotating storm system that forms over tropical waters. The typical hurricane is roughly circular in shape and ranging from 300 to 1,000 km across. Winds of hurricane speed — 118 km/h and higher — are confined to a relatively small area typically within a few tens of kilometres of the centre of the storm's path.

What Causes Hurricanes?

Hurricane formation requires the following:

- an initial low pressure disturbance over a large expanse of warm water; evaporation of this water will produce thunderstorm clouds which can intensify the resulting storm.
- a location far enough from the Equator so that winds will circulate around a centre of low pressure. The Coriolis force (a consequence of the Earth's rotation) is the source of this circulation. There is no Coriolis force at the Equator; the Coriolis force increases as latitude increases.
- certain wind patterns at various altitudes, to ensure that the developing storm will not simply blow apart.

Hurricanes usually form in late summer or early fall. Many hurricanes that strike North America form in the tropical waters of the Atlantic Ocean or Caribbean Sea, move on a westerly to northerly track, steered by the prevailing wind direction, and strike the mainland on either the Gulf or Atlantic coasts.

Stages of Hurricane Development

Tropical Disturbance — The first stage is a collection of thunderstorms forming in the easterly flow over warm tropical waters with only slight rotation.

Tropical Depression — Next the storm develops a well-defined centre of low pressure with winds of 37 to 62 km/h.

Tropical Storm — Next the storm becomes an intense centre of low pressure and carries winds of between 63 and 117 km/h.

Hurricane — When the wind speeds are 118 km/h and higher, the storm is considered a hurricane.

Hurricane Structure

Here are the major features within a hurricane (see diagram on next page).

Eye — The eye is the small region of relatively calm and clear air in the centre; the eye may be only a few tens of kilometres across.

Eye Wall — The eye is surrounded by clouds that make up the eye wall; here the weather is most severe with high winds and heavy precipitation.

Spiral Bands — Feeding into the wall cloud region are spiral bands of clouds, often composed of strong thunderstorms.

Motion of Hurricanes

The forward movement of hurricanes is relatively slow, usually up to about 15 to 25 km/h in the lower latitudes. The path of the hurricane is determined by the complex interactions with wind currents aloft and the existing large-scale weather patterns. The resulting paths can be

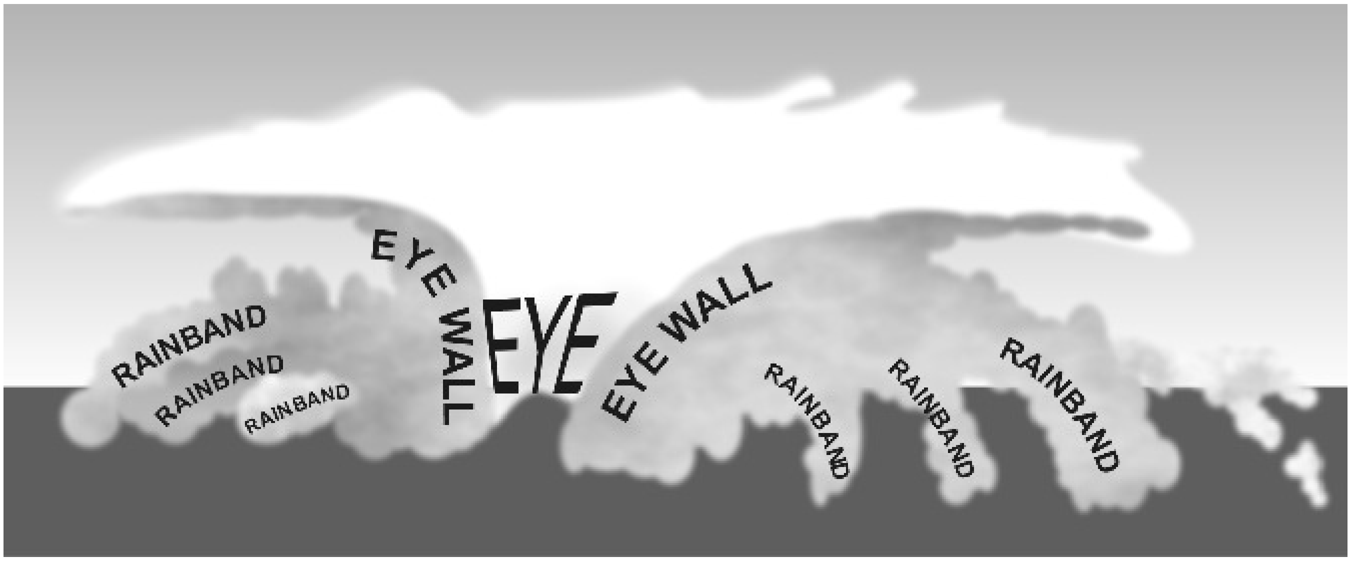


Illustration of Vertical section of a hurricane, displaying the eye, eye wall and surrounding spiral rain bands

erratic and difficult to forecast. The diagram below shows the paths of several hurricanes.

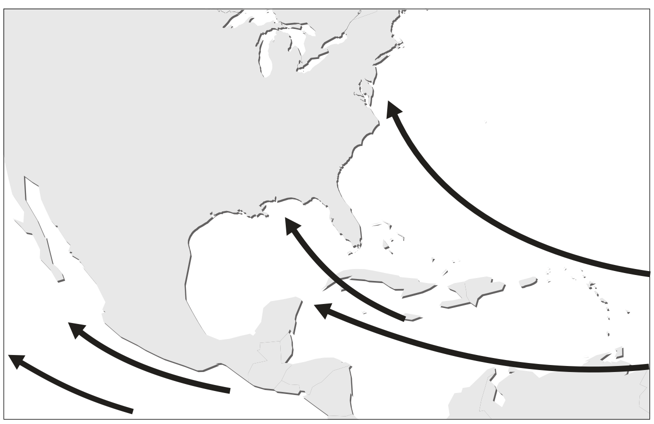


Illustration of typical paths of motion of hurricanes in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico.

The hurricane is a system of winds rapidly spiralling into the low pressure centre (counter-clockwise in the Northern Hemisphere) as it moves slowly forward. On the right side of the storm's track, the storm's forward motion reinforces the wind. On the other side of the track, the air and storm motions compete, reducing wind speeds. Consequently, storm damage is usually most severe north and east of the eye's landfall and can vary considerably over distances as small as 50 kilometres.

Energy Source

Hurricanes get their energy from evaporation over large expanses of warm tropical water with water temperatures greater than 26°C. Evaporation from warm water surfaces produces water vapour that carries tremendous amounts of energy into the growing storm. Subsequent condensation of this water releases this energy and intensifies the storm.

As hurricanes move over colder water or land, they lose their warm-water energy source and weaken in intensity.

Hurricane Damage

Major damage due to a hurricane is caused by two factors:

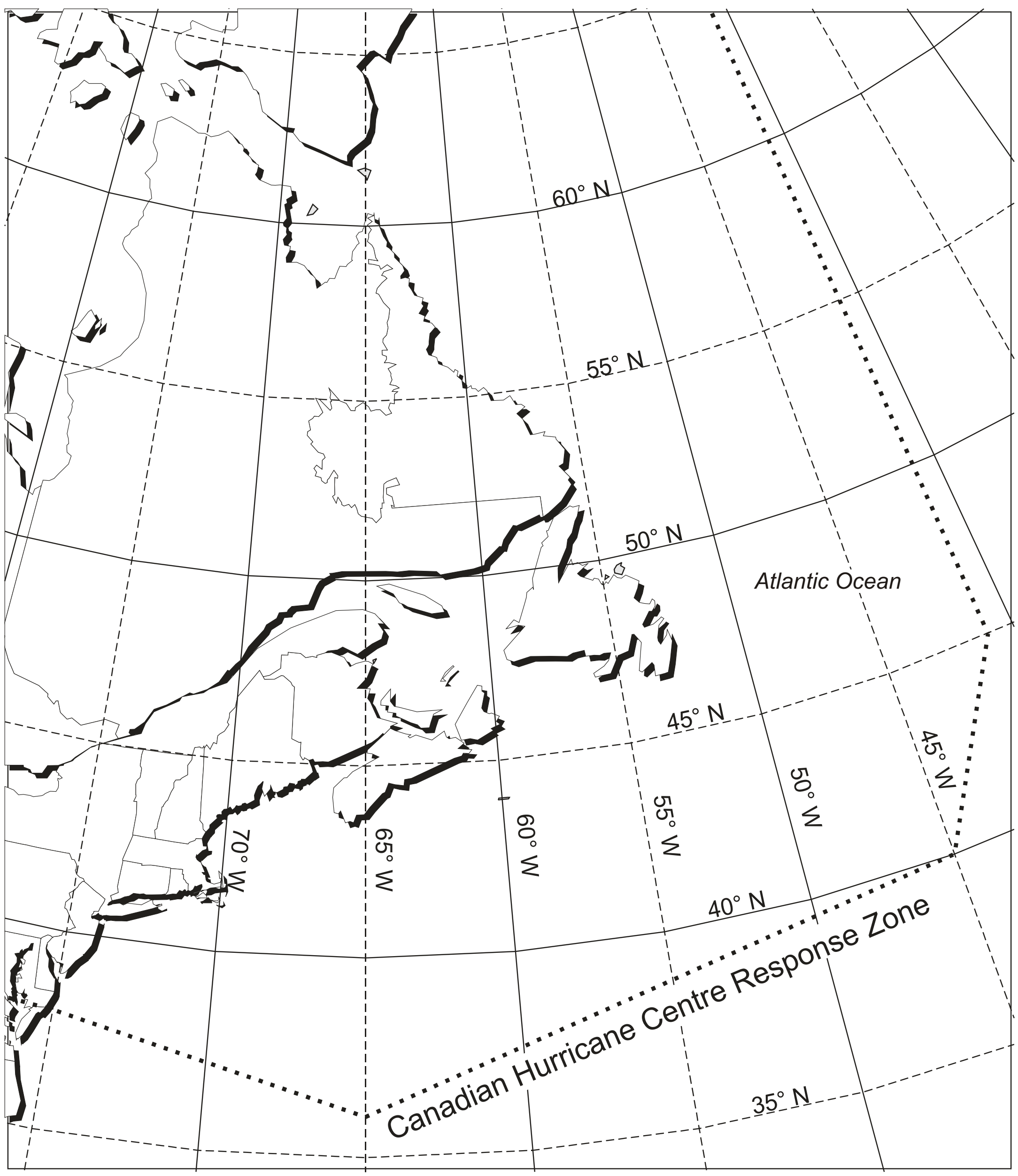
Storm Surge — Many people are surprised to learn that 90% of hurricane deaths are due to high water rather than high winds. Due to the low pressure and strong winds, hurricanes create a huge mound of water called a storm surge, especially in shallow coastal waters. As the surge sweeps ashore, the high water can flow right over sea walls and destroy protective sand dunes; when the surge coincides with high tide, the increase in water level can be as much as 6 metres. Large-scale evacuations of people from low-lying areas, such as the Gulf Coast or the Outer Banks of North Carolina, prevent massive loss of life due to such flooding.

Wind Damage — Hurricane winds have been recorded at speeds up to 300 km/h.. Beyond the damage caused directly by such winds, wind- driven waves on top of the storm surge compound the flooding problem by battering and eroding coastal features.

Hurricane and tropical Storm Bulletins

These are issued by the Canadian Hurricane Centre when a tropical storm or hurricane is forecast to enter Canada's Response Zone within 72 hours.

CANADIAN HURRICANE CENTRE RESPONSE ZONE



Canada's response zone for hurricane and tropical storm bulletins

ACTIVITY — Track of Hurricane Diana

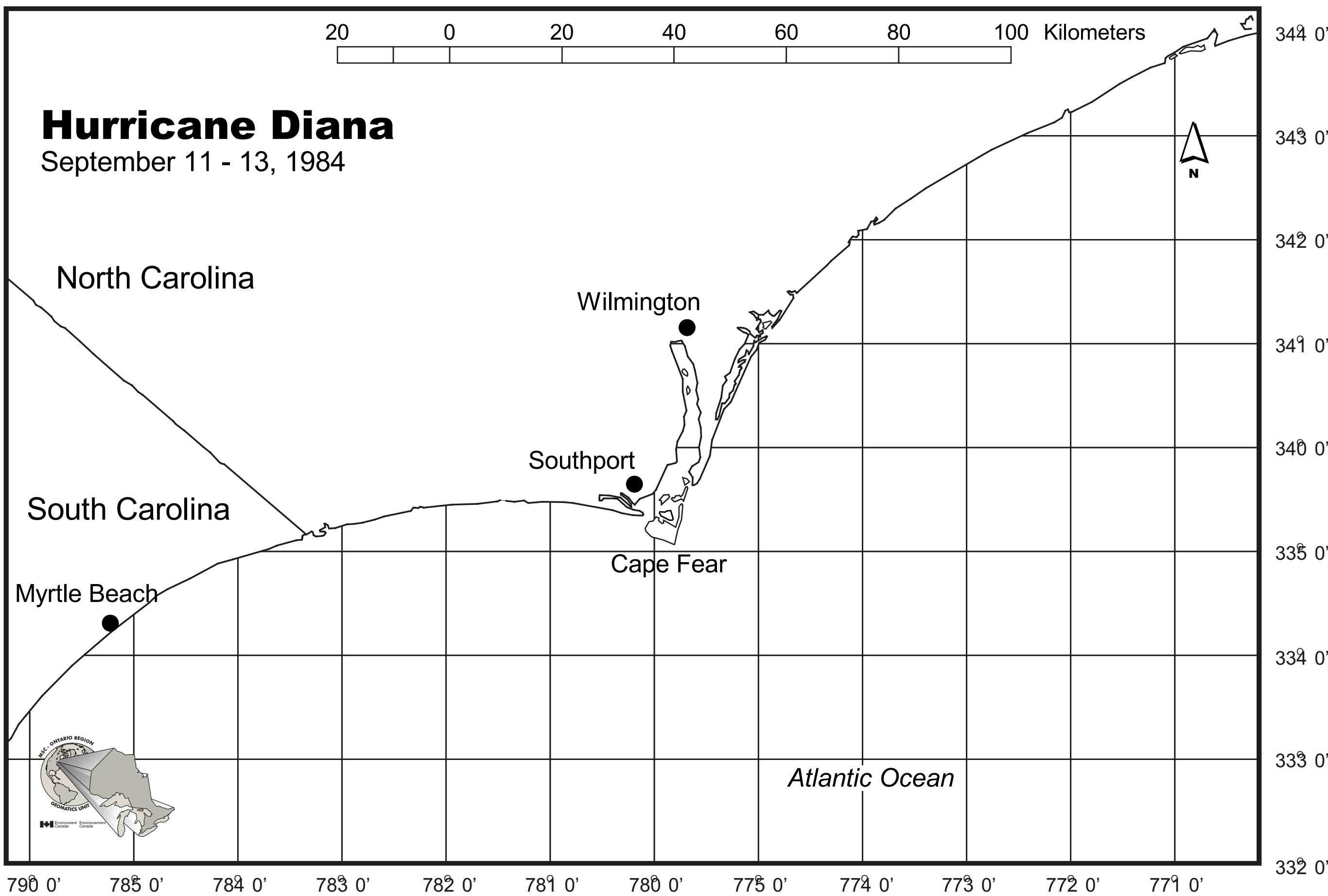
Upon completion of this exercise you should be able to:

- describe how a hurricane can be tracked
- observe the unpredictable path of a hurricane
- use the track of a hurricane to plan a disaster relief program

The map provided shows the area adjacent to Wilmington, North Carolina (population approximately 50,000). This region has extensive private and resort beachfront development.

Use the map below to plot the track of Hurricane Diana from the positions given in the accompanying table on page 19. Each position shows the centre of the storm for the time indicated in the chart. These positions are given as latitude and longitude.

Start by plotting all positions (beginning with the location at 1800 EST on 11 September); label each position with the corresponding number from the table. Connect the points with a smooth curve to show the path of Hurricane Diana.



Hurricane Diana September 11-13, 1984

			Centre Position		From Wilmington	
Date	Time (EST)	Plot Number	North Latitide	West Longitude	Distance (kilometre)	Direction
9/11	1800	1	33° 42'	77° 45'	60	SSE
	2100	2	33° 49'	77° 39'	50	SE
9/12	0000	3	33° 54'	77° 35'	48	SE
	0300	4	33° 54'	77° 25'	60	SE
9/12	0600	5	33° 54'	77° 10'	79	ESE
	0700	6	33° 55'	77° 09'	80	ESE
	0800	7	33° 57'	77° 10'	79	ESE
9/12	0900	8	33° 55'	77° 12'	77	ESE
9/12	1200	9	33° 52'	77° 11'	80	ESE
9/12	1500	10	33° 47'	77° 13'	80	SE
9/12	1800	11	33° 43'	77° 22'	78	SE
9/12	2100	12	33° 43'	77° 31'	68	SSE
9/13	0000	13	33° 50'	77° 47'	45	SSE
*	0115	14	33° 54'	77° 57'	35	S

* Landfall (on an island SE of Southport, NC)

Diana organized as a tropical storm off the Bahamas on September 8th, 1984. It then approached the Florida coast before turning northward to parallel it. Diana reached hurricane strength while approaching North Carolina on the 11th, then weakened and made landfall. Finally, Diana wandered back off-shore on the 14th, intensified before heading toward Newfoundland and extinction. Wind damage, beach erosion, and 18 inches of rain produced $78 million damage in the Wilmington, NC area.

(Source: Storm Data, September, 1984, Vol. 26, No. 9, NOAA, National Climatic Data Centre)

1. If you were a meteorologist, what would you tell people living along the coast in the map area?

2. If you were in charge of emergency management for the land area shown on the map, what action would you take, if any? Consider that it will take a few hours to alert people in your exposed areas and allow them to evacuate, if needed. Your decisions can affect many lives.

3. What types of emergency personnel and supplies will be needed if widespread damage occurs?

Additional Activities:

a) When a tropical storm or hurricane is reported, monitor radio and television for information on the storm's progress. Plot the position of the storm's centre on a classroom map or tracking chart. Also mark the coastline along which hurricane watches and warnings have been issued.

b) Invite persons who have lived through hurricanes to speak about their experiences to the class.

c) What can individuals, families, and communities in coastal areas do to meet the hurricane threat? If you live in a coastal area, what are the preparedness and response plans of your family and community?