Hurricane Tracking Lab

Background: Hurricanes are one of nature's most powerful disasters. To equal the power of a hurricane, one would have to set off about a thousand nuclear devices per second for as long as the hurricane rages. Hurricane season runs from June 1st to November 30th every year due to thunderstorms forming over the hot, moist air in the Atlantic Ocean. While it is very difficult to predict where a hurricane will travel, prediction is very important – especially if you are in its path. In this lab you will be plotting the path of some of the most deadly and devastating recent hurricanes to hit the United States. You will be asked to analyze the strength of the hurricanes; compare their speed of travel; and the path of their destruction.

"The greatest potential for loss of life related to a hurricane is from the storm surge." states Brian Jarvinen, from the National Hurricane Center. Storm surge is simply water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. In addition, wind driven waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with normal high tides. Being that much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level, the danger from storm tides is tremendous.

Weather satellites collect latitude and longitude coordinates which allow us to accurately plot the hurricane pathway, but they do not always 100% predict correctly when and where the hurricane will make land-fall. It is the responsibility of the **National Hurricane Center** to provide information to the public about where and when a hurricane will strike. Hurricanes begin as tropical depressions, which is an organized system of clouds and thunderstorms with a defined surface circulation and maximum winds of 38 mph. When these winds reach 39-73 mph, it is no longer a depression but is now a tropical storm. When wind speed exceeds 74 mph, the storm is now termed a hurricane and will be categorized based on the Saffir-Simpson Scale. A hurricane watch is issued for any place where a hurricane is predicated to make land-fall within 24-26 hours and a hurricane warning is issued for any place where a hurricane is predicated to make land-fall within less than 24 hours.

Saffir-Simpson Scale: The Saffir-Simpson Hurricane Scale is a 1-5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane land-fall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the land-fall region.

Category	Wind Speed	Description
Tropical Storm	39-73 mph	
1	74-95 mph	No real damage to buildings. Damage to unanchored mobile homes. Some damage to poorly constructed signs. Also, some coastal flooding and minor pier damage.
2	96-110 mph	Some damage to building roofs, doors and windows. Considerable damage to mobile homes. Flooding damages piers and small craft in unprotected moorings may break their moorings. Some trees blown down.
3	111-130 mph	Some structural damage to small residences and utility buildings. Large trees blown down. Mobile homes and poorly built signs destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well in-land.
4	131-155 mph	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well in-land.
5	156 mph +	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation likely.

Materials: hurricane plotting map; colored pencils

Directions: Plot the various hurricane paths on the provided Hurricane Tracking Map. Use a different colored pencil for each hurricane. Use the Saffir-Simpson Scale to determine the category of each given latitude and longitude reading. Complete the analysis and conclusion questions. **Note**: latitude and longitude readings are given in degrees and minutes (remember each degree can be divided into 60 minutes.)

******When doing the lab report write-up, be sure to follow the guidelines.******

<u>Hurricane Andrew (1992)</u>: Hurricane Andrew was one of the most destructive United States hurricanes on record. It blasted its way across south Florida on August 24, 1992. NOAA's National Hurricane Center had a peak gust of 164 mph—measured 130 feet above the ground—while a 177 mph gust was measured at a private home. Andrew caused 23 deaths in the United States and three (3) more in the Bahamas. The direct loss of life seems remarkably low considering the destruction caused by this hurricane. The hurricane caused $26.5 billion in damage in the United States, making Andrew the third most expensive natural disaster in U.S. history. Plot the following points as an "X" on your map; connect your points with a colored pencil. Label the category of the storm at each point. Note: readings taken ***every 12 hours.***

	Month	**Day**	**Time**	**N. Lat**	**W. Long**	**MPH**	**Category**
1	Aug	20	00:00 AM	21º, 40'	60º, 40'	46	
2	Aug	20	12:00 PM	23º, 10'	62º, 35'	52	
3	Aug	21	00:00 AM	24º, 25'	64º, 10'	58	
4	Aug	21	12:00 PM	25º, 20'	65º, 55'	63	
5	Aug	22	00:00 AM	25º, 50'	68º, 20'	81	
6	Aug	22	12:00 PM	25º, 35'	71º, 05'	104	
7	Aug	23	00:00 AM	25º, 25'	74º, 10'	138	
8	Aug	23	12:00 PM	25º, 25'	77º, 30'	155	
9	Aug	24	00:00 AM	25º, 35'	81º, 10'	127	
10	Aug	24	12:00 PM	26º, 10'	85º, 00'	132	
11	Aug	25	00:00 AM	27º, 10'	88º, 10'	132	
12	Aug	25	12:00 PM	28º, 30'	90º, 30'	138	
13	Aug	26	00:00 AM	30º, 00'	91º, 40'	92	
14	Aug	26	12:00 PM	31º, 30'	91º, 00'	40	

<u>Hurricane Jeanne (2004)</u>: Jeanne hit Florida after Hurricanes Charley, Frances, and Ivan. In six (6) weeks these storms shut down much of the state and prompted recovery plans on a scale never before seen in the nation. Jeanne was blamed for at least six (6) deaths in Florida. The storm had already cut a deadly path through the Caribbean, where floods in Haiti, the Dominican Republic and Puerto Rico killed over 3,000 people. Haiti suffered the heaviest toll. Two (2) days of torrential rains caused massive flooding and mudslides in the northern region, killing close to 3,000 people. Plot the following points as an "X" on your map; connect your points with a second colored pencil. Label the category of the storm at each point. Note: readings taken ***every 6 hours.***

	Month	Day	Time	N. Lat	W. Long	MPH	Category
1	Sept	20	05:00 PM	27º, 25'	71º, 15'	80	
2	Sept	20	11:00 PM	27º, 25'	70º, 35'	80	
3	Sept	21	05:00 AM	27º, 40'	70º, 00'	85	
4	Sept	21	11:00 AM	27º, 30'	69º, 20'	85	
5	Sept	21	05:00 PM	27º, 20'	68º, 50'	85	
6	Sept	21	11:00 PM	27º, 00'	68º, 45'	85	
7	Sept	22	05:00 AM	26º, 40'	68º, 40'	85	
8	Sept	22	11:00 AM	26º, 20'	68º, 30'	90	
9	Sept	22	05:00 PM	26º, 05'	69º, 00'	90	
10	Sept	22	11:00 PM	25º, 40'	69º, 20'	90	
11	Sept	23	05:00 AM	25º, 30'	69º, 30'	90	
12	Sept	23	11:00 AM	25º, 40'	69º, 40'	95	
13	Sept	23	05:00 PM	25º, 55'	70º, 20'	95	
14	Sept	23	11:00 PM	26º, 05'	70º, 45'	95	
15	Sept	24	05:00 AM	26º, 05'	71º, 35'	90	
16	Sept	24	11:00 AM	26º, 15'	72º, 25'	90	
17	Sept	24	05:00 PM	26º, 25'	73º, 30'	90	
18	Sept	24	11:00 PM	26º, 30'	74º, 55'	90	
19	Sept	25	05:00 AM	26º, 30'	76º, 10'	95	
20	Sept	25	11:00 AM	26º, 35'	77º, 35'	105	
21	Sept	25	05:00 PM	27º, 10'	78º, 40'	115	
22	Sept	25	11:00 PM	27º, 15'	80º, 00'	110	
23	Sept	26	05:00 AM	27º, 25'	81º, 10'	95	

<u>Hurricane Ernesto (2006)</u>: Remnants of this storm brought many Labor Day plans in the New York City region to a halt. Wind speeds of over 50 mph brought many trees and limbs down causing massive power outages all along the South Shore of Long Island. Beach erosion hit Robert Moses State Park most severely, affecting nearly the entire beachfront. Sunken Meadow Park on the North Shore of Long Island, lost up to four (4) feet of sand dunes. The wind pushed the sand up to the point where a lake, up to three (3) feet deep, was created on Jones Beach near the West Bathhouse. At least six (6) people died in North Carolina and Virginia as the storm made its way up the Eastern Seaboard. Plot the following points as an "X" on your map; connect your points with a third color pencil. Label the category of the storm at each point. Note: readings taken ***every 12 hours.***

	Month	**Day**	**Time**	**N. Lat**	**W. Long**	**MPH**	**Category**
1	Aug	25	03:00 AM	13º 12'	63º 54'	35	
2	Aug	25	03:00 PM	13º 30'	66º 24'	35	
3	Aug	26	03:00 AM	14º 48'	69º 06'	45	
4	Aug	26	03:00 PM	15º 06'	71º 12'	50	
5	Aug	27	03:00 AM	16º 48'	72º 42'	60	
6	Aug	27	03:00 PM	17º 36'	73º 42'	75	
7	Aug	28	03:00 AM	18º 36'	74º 42'	50	
8	Aug	28	03:00 PM	20º 18'	75º 42'	40	
9	Aug	29	03:00 AM	21º 42'	78º 48'	40	
10	Aug	29	03:00 PM	23º 18'	79º 30'	45	
11	Aug	30	03:00 AM	24º 54'	80º 30'	45	
12	Aug	30	03:00 PM	26º 24'	80º 54'	35	
13	Aug	31	03:00 AM	28º 42'	80º 36'	35	
14	Aug	31	03:00 PM	31º 18'	79º 36'	60	
15	Sept	1	03:00 AM	33º 54'	78º 12'	70	
16	Sept	1	03:00 PM	36º 24'	77º 36'	35	
17	Sept	2	03:00 AM	37º 30'	76º 48'	40	
18	Sept	2	03:00 PM	38º 42'	76º 48'	50	
19	Sept	3	03:00 AM	40º 42'	76º 54'	35	

Hurricane Katrina (2008) : This hurricane is the costliest natural disaster as well as one of the five (5) deadliest hurricanes in the history of the United States. This storm is the third most intense United States land-falling tropical hurricane, behind only the 1935 Labor Day Hurricane and Hurricane Camille in 1969. Overall, at least 1,245 people died in the hurricane and subsequent floods, making it the deadliest United States hurricane since the 1929 Okeechobee Hurricane. Total property damage is estimated at $108 billion dollars, roughly four (4) times the damage wrought by Hurricane Andrew in 1992. The response of federal, state and local agencies to this storm was investigated intensely. The investigation led to the resignations of Federal Emergency Management Agency (FEMA) Director Michael D. Brown and of the New Orleans Police Department (NOPD) Superintendent Eddie Compass. Many other government officials were criticized for their responses, especially New Orleans Mayor Ray Nagin; Louisiana Governor Kathleen Blanco and President George W. Bush. Several agencies including the United States Coast Guard (USCG); National Hurricane Center (NHC); and National Weather Service (NWS) were commended for their actions. Plot the following points as an "X" on your map; connect your points with a fourth colored pencil. Label the category of the storm at each point. Note: readings taken ***every 12 hours.***

	Month	**Day**	**Time**	**N. Lat**	**W. Long**	**MPH**	**Category**
1	Aug	24	12:00 PM	23° 4'	75° 7'	26	
2	Aug	24	00:00 AM	24° 5'	76° 5'	30	
3	Aug	25	12:00 PM	26° 0'	77° 7'	39	
4	Aug	25	00:00 AM	26° 2'	79° 0'	48	
5	Aug	26	12:00 PM	25° 9'	80° 3'	61	
6	Aug	26	00:00 AM	25° 1'	82° 0'	65	
7	Aug	27	12:00 PM	24° 6'	83° 3'	78	
8	Aug	27	00:00 AM	24° 4'	84° 7'	87	
9	Aug	28	12:00 PM	24° 8'	85° 9'	87	
10	Aug	28	00:00 AM	25° 7'	87° 7'	126	
11	Aug	29	12:00 PM	27° 2'	89° 2'	122	
12	Aug	29	00:00 AM	29° 5'	89° 6'	96	
13	Aug	30	12:00 PM	32° 6'	89° 1'	43	
14	Aug	30	00:00 AM	35° 6'	88° 0'	26	

Hurricane Sandy (2012): Unofficially known as Superstorm Sandy, it is the second-costliest hurricane in United States history. Sandy was a Category 3 storm at its peak intensity when it made land-fall in Cuba. While it was a Category 2 storm off the coast of the Northeastern United States, the storm became the largest Atlantic hurricane on record (as measured by diameter, with winds spanning 1,100 miles.) Estimated assessed damages is to have been about $75 billion dollars, a total surpassed only by Hurricane Katrina. At least 233 people were killed along the path of the storm in eight (8) countries. Hurricane Sandy affected 24 states, including the entire eastern seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin. Plot the following points as an "X" on your map; connect your points with a fifth colored pencil. Label the category of the storm at each point. Note: readings taken ***every 12 hours.***

	Month	**Day**	**Time**	**N. Lat**	**W. Long**	**MPH**	**Category**
1	Oct	24	01:00 PM	17° 6'	76° 8'	80	
2	Oct	25	01:00 AM	20° 1'	75° 9'	110	
3	Oct	25	01:00 PM	23° 5'	75° 4'	105	
4	Oct	26	01:00 AM	25° 8'	76° 5'	85	
5	Oct	26	01:00 PM	27° 1'	77° 1'	75	
6	Oct	27	01:00 AM	28° 1'	76° 9'	75	
7	Oct	27	01:00 PM	29° 7'	75° 6'	75	
8	Oct	28	01:00 AM	31° 5'	73° 7'	75	
9	Oct	28	01:00 PM	32° 8'	71° 9'	75	
10	Oct	29	01:00 AM	35° 2'	70° 5'	75	
11	Oct	29	01:00 PM	38° 3'	73° 1'	90	
12	Oct	30	01:00 AM	38° 8'	74° 4'	90	
13	Oct	30	01:00 PM	39° 8'	75° 4'	75	

Analysis and Conclusion Questions

1. Mark the 30º N Latitude line on your map. State the general direction that the storms moved below this line. What direction did the storms move above this line?

2. Cuba is 1,140 km across. Create a scale for your map. Show your work.

3. Speed is distance divided by time. What was the average speed ***(not wind speed)*** of Hurricane Andrew between data points #5 and #11? Show your work.

4. What was the average speed ***(not wind speed)*** of Ernesto between data points #9 and #19? Show your work.

5. In what state did Katrina first make land-fall?

6. Why did hurricane Katrina slow down at data point #7?

7. What was the status of hurricane Katrina when it passed into New Orleans?

8. Where were the storms located when they had their strongest winds?

9. What happens to the wind speeds and intensity of the storm as they move over land?

10. Based on what you know about seasons and hurricanes, make an inference about why most hurricanes form in the months of July, August and September.

11. Compare and contrast the pathway of Hurricane Sandy to the pathway of Hurricane Katrina. Explain what you think could have caused Sandy's path to be so different.