MiSP Weather — Wind Speed and Direction Worksheet #3 L2

Name _____ Date _____

HURRICANES — PRESSURE AND WIND SPEED

Introduction (excerpts from http://www.srh.noaa.gov/jetstream/tropics/tc.htm):

A tropical cyclone is a warm, low pressure system that develops over tropical or subtropical waters, and has an organized circulation. Depending upon location, tropical cyclones have different names around the world.

- In the Atlantic / eastern Pacific oceans, they are called *hurricanes*.
- In the western Pacific Ocean, they are called *typhoons*.
- In the Indian Ocean, they are called *cyclones*.

Regardless of what they are called, there are several favorable environmental conditions that must be in place before a tropical cyclone can form. They are:

- Warm ocean waters (at least 80°F/27°C).
- Relatively moist air near the mid-level of the troposphere (16,000 ft/4,900 m).
- Generally a minimum distance of 300 miles (480 km) from the equator. This allows the **Coriolis Force** to cause the cyclone to spin.

The warm water is one of the most important keys as it is water that powers the tropical cyclone. As water vapor (water in the gaseous state) rises, it cools. This cooling causes the water vapor to condense into a liquid that we see as clouds. In the process of condensation, heat is released. This heat warms the atmosphere, making the air less dense and lower in pressure. This causes the air to rise higher into the atmosphere. As it does, higher pressure air moves in near the surface to take its place. This is the strong wind we feel from these storms.

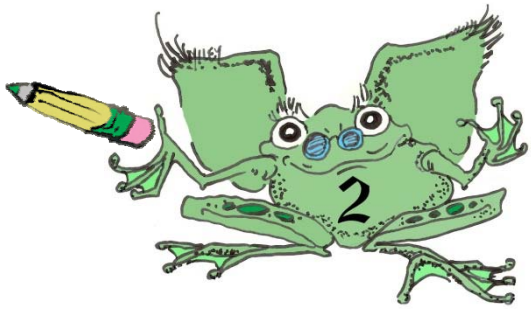
Once the storm moves over land, it will begin to weaken rapidly, not because of friction, but because the storm lacks the moisture and heat sources that the ocean provided.

Problem:

How does hurricane central pressure affect wind speed?

Hypothesis:

If central pressure **decreases**, then hurricane wind speed _____.



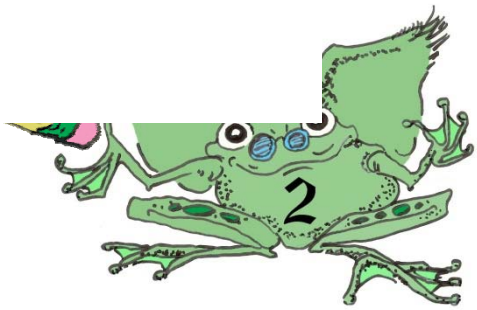
Procedures:

Data in the chart below is from the first eight days of the tropical storm that became Hurricane Ike. Hurricane Ike occurred in 2008 from September 1 to September 15. It caused 103 deaths and cost over $19 billion in property damage.
Central pressure is the low pressure inside the eye of the tropical cyclone / hurricane. The difference between the higher pressure outside the eye and the lower pressure inside the eye produces the wind of the storm. Remember: Wind occurs when air blows from areas of high pressure to areas of low pressure.

HURRICANE IKE

Date:	Time:	NLat:	WLon:	Central Pressure (mb):	Wind (mph):	Storm Type:
1-Sep	06 GMT	17.2	37.0	1006	35	Tropical Depression
1-Sep	18 GMT	17.5	39.9	1003	50	Tropical Storm
2-Sep	06 GMT	18.2	42.8	1000	50	Tropical Storm
2-Sep	18 GMT	19.3	45.8	996	65	Tropical Storm
3-Sep	06 GMT	20.2	48.8	992	65	Tropical Storm
3-Sep	18 GMT	21.1	51.9	979	85	Category 1 Hurricane
4-Sep	06 GMT	22.4	55.0	935	145	Category 4 Hurricane
4-Sep	18 GMT	23.4	57.7	940	135	Category 4 Hurricane
5-Sep	06 GMT	23.6	60.4	949	135	Category 4 Hurricane
5-Sep	18 GMT	23.2	63.4	959	115	Category 3 Hurricane
6-Sep	06 GMT	22.4	66.3	964	115	Category 3 Hurricane
6-Sep	18 GMT	21.5	69.0	950	135	Category 4 Hurricane
7-Sep	06 GMT	21.1	71.6	947	135	Category 4 Hurricane
7-Sep	18 GMT	21.0	74.0	946	120	Category 3 Hurricane
8-Sep	06 GMT	21.1	76.5	950	115	Category 3 Hurricane
8-Sep	18 GMT	21.2	79.1	964	85	Category 1 Hurricane

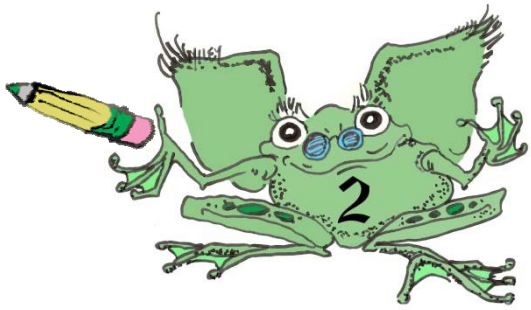
Graph the data:

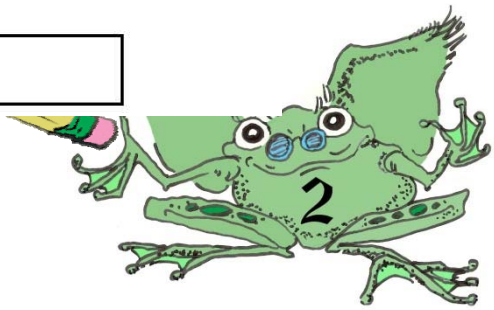


1. Use data from the chart and the graph below to show the relationship between the hurricane central pressure (mb) and the wind speed (mph).

- Label the *x*-axis.
- Label the *y*-axis.
- Draw a best-fit line of the data.

2. On the separate Atlantic Hurricane Tracking Chart, plot the first eight days of tropical storm / Hurricane Ike. Use the latitude and longitude. Label each position with the date and the time (GMT = Greenwich Mean Time = the time at 0^{o} longitude).

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Discussion Questions:

1a. Explain the relationship between hurricane central pressure and wind speed by completing this statement: As the central pressure of a hurricane

INCREASES, the wind speed of the hurricane _____.

1b. How is the relationship in 1a shown by the graph? (This type of relationship is called an indirect relationship.)

_____

_____

2. You drew a best-fit line to show the linear relationship between central pressure and wind speed. Some data points were on the line, some above it, and some below it. Besides central air pressure, what other variables may affect the speed of the wind inside a tropical depression, storm, or hurricane?

_____

_____

_____

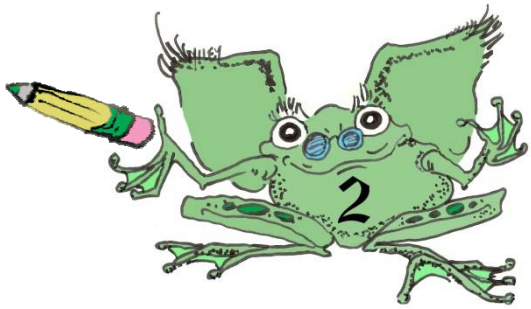
3. Using the best-fit line of your graph, what would the wind speed be if a hurricane had a central pressure of 970 mb?

_____

4. Look at the map with the hurricane positions plotted. Using that information, suggest an explanation of why the hurricane lost intensity and became a class 1 hurricane on September 8, 18:00 GMT, with a wind speed of 85 mph, after being a class 3 hurricane 12 hours earlier at 6:00 GMT, with a wind speed of 115 mph.

_____

_____



5a. How much does a change of 1.0 mb of pressure in a tropical storm / hurricane affect the wind speed? Find out by calculating the unit rate of change (slope) of the best-fit line. *(When using the best-fit line, the ordered pairs to determine slope must be from the best-fit line, not from your data chart.)*

$$\text{Unit Rate of Change} = \frac{\Delta \text{ Wind Speed (mph)}}{\Delta \text{ Pressure (mb)}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)}$$

Ordered Pair used for calculation (x_1, y_1) (x_2, y_2)	Δ Wind Speed (mph) Δy	Δ Pressure (mb) Δx	**Unit Rate of Change (slope)** $\Delta y / \Delta x$

5b. What is the sign (negative/- or positive/+) of the slope? What does that tell you about how changes in the pressure affect wind speed?

_____

_____

_____

5c. Using the slope, what is the expected change in wind speed if the pressure

increases by 10 mb?_____

decreases by 20 mb?_____